DISCOVERY

APRIL 1958 2/6

. . . . the unerring laws

" Chemical science during the last quarter of a century has made such extended progress that our arts and manufactures assume altogether a different aspect. Those chemical arts which formerly were rudely conducted by the system termed the 'rule of thumb' are now methodically organised and arranged in accordance with the unerring laws of chemistry . . . Hence, not only are more accurate and uniform results obtained, but success and economy take the place of failure and waste." (*Chemical News*, 1859, **1**, 1).

Here, in the first number of 'Chemical News' published nearly a hundred years ago, the eventual development of scientific control of the methods and means of production is welcomed perhaps a little prematurely; but in thousands of industrial laboratories to-day 'the unerring laws of chemistry,' and B.D.H. reagents, enable the conduct of the chemical arts to be successful and economical . . . and as civil as you please.

B.D.H. LABORATORY CHEMICALS

THE BRITISH DRUG HOUSES LTD. B.D.H. LABORATORY CHEMICALS GROUP POOLE DORSET

LC/P/9 fr

NEWPORT INSTRUMENTS — SCIENTIFIC MOBILE

Direct Reading Magnetometer

Write for fully descriptive literature, without obligation, to:

This instrument is primarily designed to measure the variations in fields of television focus magnets, for the investigation of permanent magnets and the measurement of stray fields of transformers and electromagnets. The instrument has extremely high sensitivity, and a ten-fold increase in sensitivity is available by a front panel switch. It has also been found suitable for examining the fields of the large focusing electromagnets associated with Particle accelerators.

The normal ranges of the instrument are from: 0–5 oersteds; 0–50 oersteds; and 0–500 oersteds. It is supplied complete with probe by which all these ranges are obtainable.

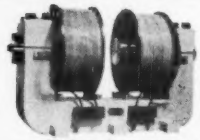
Sturdily constructed, the instrument measures 11″ × 20″ × 10″: weight 30 lb.

OTHER N.I.

TEACHING MAGNET

Designed for instructional purposes this electromagnet gives 8000 gauss at 1 cm. separation. Input 150V at 3 amps.; 1½″ pole pieces. Also suitable for paramagnetic experiments. Price £60 ex works (U.K.).

PRODUCTS



High-performance Electromagnet (Type A)

& SERVICES

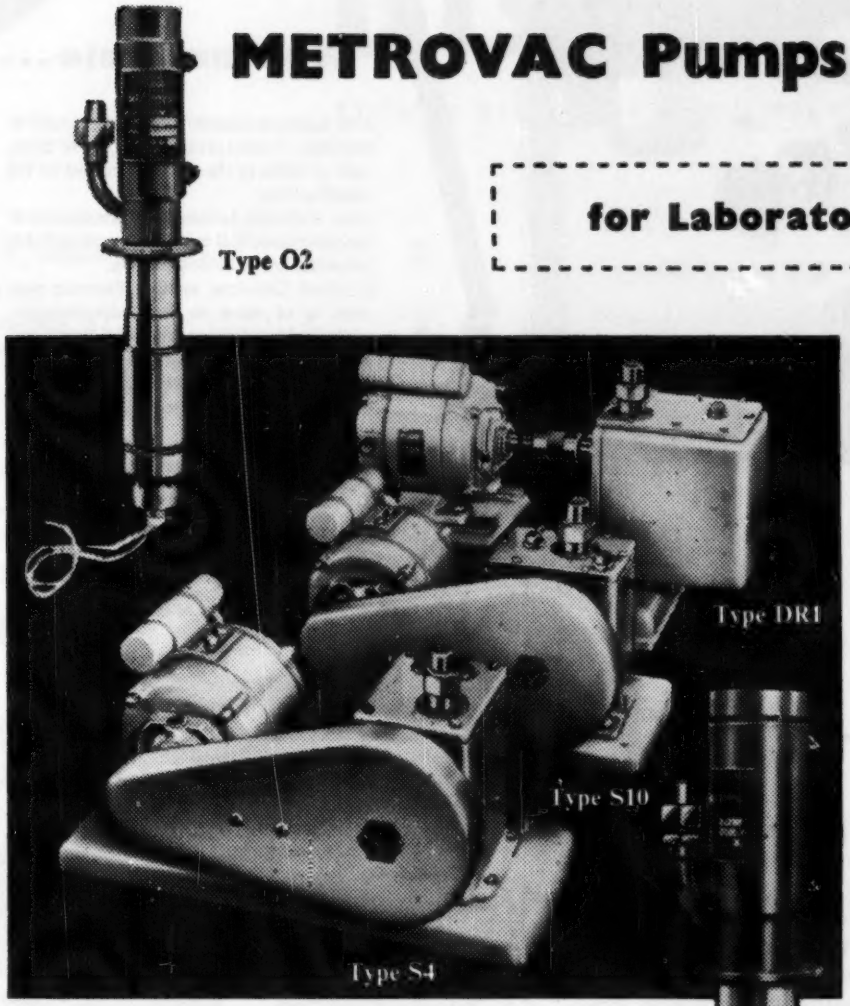
Newport Instruments Ltd have available a large skilled capacity for coil winding of all kinds and sizes including the smaller types of toroidially wound coils for use in computers, etc. A general electro-mechanical contracts department is also available.

NEWPORT INSTRUMENTS (SCIENTIFIC & MOBILE) LTD

NEWPORT PAGNELL · BUCKS · ENGLAND Telephone Newport Pagnell 401/2

METROVAC Pumps

for Laboratories



The Metrovac range of pumps includes both rotary and oil diffusion types suitable for a wide variety of high vacuum applications in the laboratory.
In selecting the pump or combination of pumps for any specific application, the wide experience of Metrovick engineers—specialists in the design and operation of high vacuum apparatus—is freely at your disposal. Please write for full details.

METROPOLITAN-VICKERS
ELECTRICAL CO. LTD. TRAFFORD PARK MANCHESTER

Member of the AEI group of companies

Vacuum Pumps

N/P402

Paint and powder . . .

. . . pigment and paper, or any coloured product, sets the manufacturer a problem in colour matching. That is why the colorimeter is so important to him; it enables him to keep an accurate control over the colour of his products.

Comparing colours is only one of the ways in which our instruments help industry. When analysing, surveying, inspecting or measuring, scientists and manufacturers know from experience that they can rely on the quality and accuracy of the instruments made by Hilger & Watts.

¶ The illustration shows a photoelectric Tristimulus Colorimeter, with which the colours of objects can be compared exactly and, if desired, specified in the co-ordinates of the Trichromatic System recommended by the Commission Internationale de l'Eclairage.

HILGER & WATTS LTD

98 ST PANCRAS WAY, LONDON, NW1

Remarkable...

how Eastman Organic Chemicals expand in numbers. There are now over 3,600 of them, each of value to the research chemist or the manufacturer.

Thus, Cellulose Acetate Phthalate appeals to the pharmaceutical trade, having remarkable properties as an enteric coating.

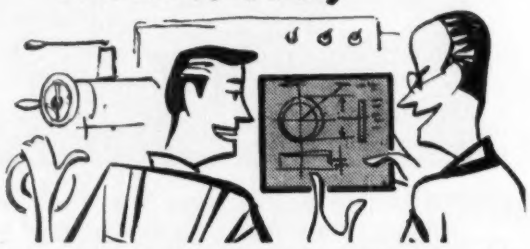
Oxidised Cellulose, another Eastman product, is of value to the endocrinologist, while Acridine Orange is a useful fluorescent indicator in the pH range 8–10.

For information on these and other Eastman Organic Chemicals write to:—

Kodak *LTD.*
Kirkby Industrial Estate,
LIVERPOOL

P.S. If you are interested in Nutritional Biochemicals Company (U.S.A.) products, we may be able to help you.

—and NOW!



BLUEPRINTS THAT STAND UP

TO HARD WEAR, WHEN MOUNTED AND SURFACED WITH TRANSPARENT

Morane Plastic Skin

Hard-surfaced blueprints, notices, diagrams, etc., which can be wiped clean with detergents, paraffin, water. Cut errors quickly by providing your staff with the simple apparatus for putting a transparent Morane skin surface on mounted and unmounted blueprints, laboratory notes, diagrams, recipe cards, job instruction cards, photographs and warning notices.

Paper can be mounted to any hard surface and glazed at the same time—in one operation lasting a few seconds only.

Just write "Blueprint protection details" on your note-paper and post to-day to:—

MORANE PLASTIC CO. LTD.
11 WOODTHORPE RD ASHFORD, MIDDX
Tel: Ashford Middx. 4016/7

DISCOVERY

VOLUME XIX APRIL 1958 NUMBER 4

Editor
Anthony R. Michaelis, PH.D., B.SC.

Editorial Office
244 High Holborn, W.C.1
CHAncery 6518

Subscription, Distribution and Business Communications to
Jarrold & Sons Ltd, Norwich
Norwich 25261

Advertisement Office
Aldridge Press Ltd,
27 Chancery Lane, W.C.2
HOLborn 8655

OUR COVER PICTURE

Roller-Tube Tissue-Culture Apparatus used for Virus Assay at the Wellcome Research Laboratories, Beckenham (see pp. 142–7).

CONTENTS

The Progress of Science 133

Future of Antarctica—Science or Politics?
Max Planck (1858–1947)
The Behaviour of Hunting-Wasps
Operation Stratoscope
Disturbed Pregnancies
The Scottish Research Laboratories Mutual Assistance Scheme
The London Planetarium
A belated *Festschrift* for N.I. Vavilov?
Hurricanes Less Mysterious?

Poliomyelitis Vaccine 142
C. L. Greening, M.R.C.S., L.R.C.P., and H. J. Parish, M.D.

The Analysis of Nuclear Particle Tracks by Digital Computer 148
Y. Goldschmidt-Clermont

The Sources of Invention 153
Lord Halsbury

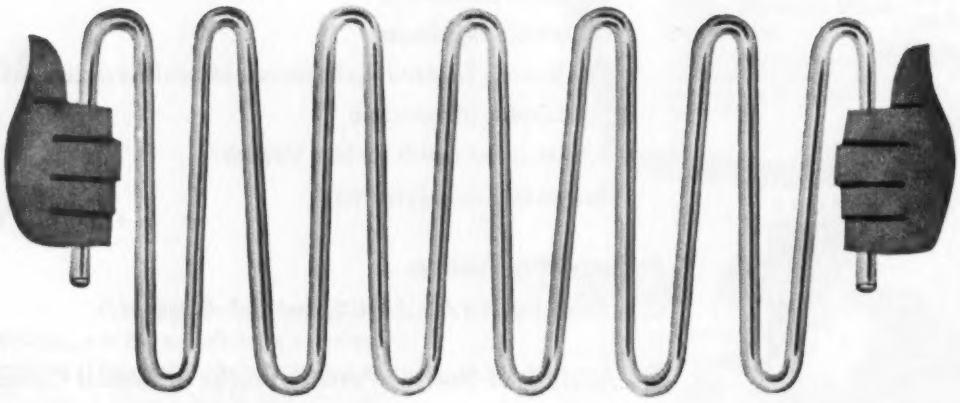
A Century of Diazo Compounds 155
E. R. Ward, PH.D., B.SC., A.R.I.C., and J. L. Randall, B.SC.

The International Geophysical Year: Month by Month 162
Angela Croome

The Bookshelf 166

Science on the Screen 172

Far and Near 174



Phoenix glass tubing meets everyone's requirements

Remarkable versatility is an everyday matter for Phoenix. It can be trusted to the most remarkable shapes without fear of fleddage or distortion.

Workability is only one outstanding quality of Phoenix. Its low coefficient of expansion prevents thermal shock and overcomes this particular danger of glass in working.

You can see through Phoenix glass clearly to check flow and density. Yet Phoenix possesses very high mechanical and thermal strength. It is produced by the latest thermal methods to ensure unvarying bore and roundness. For many of modern industry's most advanced techniques the most practical medium of all is Phoenix glass.

AVAILABLE IN 14 LB. STANDARD BUNDLES

Phoenix Heat Resisting glass tubing is packed in 14 lb. standard bundles—useful for the small and large user. While standard sizes are available ex stock, special requirements can be dealt with promptly. May we send you our catalogue?

PHOENIX GLASS TUBING AND ROD

THE BRITISH HEAT RESISTING GLASS COMPANY LIMITED

(Tech. Dept. D), Phoenix Works, Loxdale Street, Bilston, Staffs. Telephone: Bilston 41701/2/3. Telegrams: Phoenician, Bilston

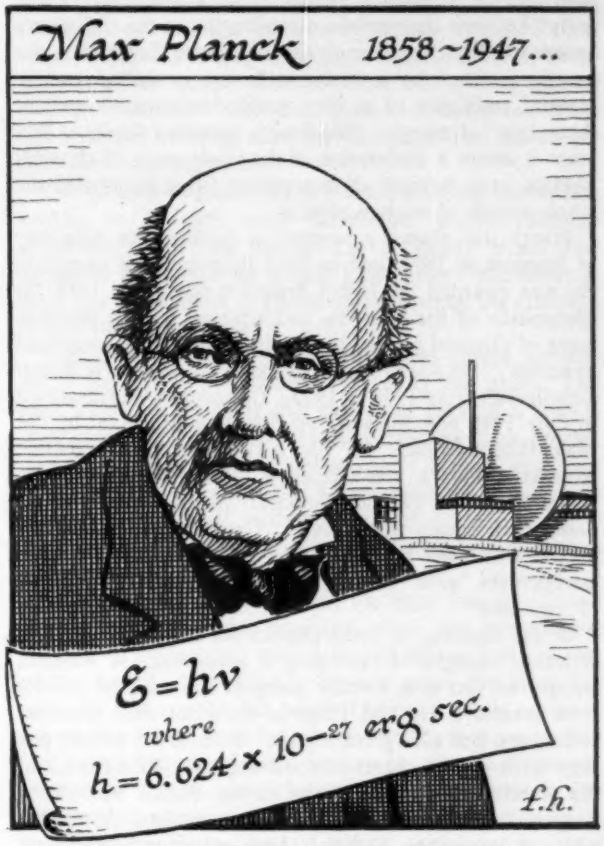
FUTURE OF ANTARCTICA—SCIENCE OR POLITICS?

Could Antarctica be retained permanently as a reserve for international science, an unspoiled natural laboratory free from the complications of politics? The area is uninhabited and no nation wants it for its intrinsic value—a unique situation; it is, moreover, extremely interesting scientifically and, even now, scarcely investigated. If there is ever to be a moment for putting through such a project it is now. Some eleven nations are concerned with sovereignty in this area and their claims conflict. The situation which is now developing enables sovereignty issues to be presented as a concern for geophysics. This is a trend not calculated to benefit either international geophysics or international politics.

The decision made in mid-February, at a meeting of distinguished scientists in The Hague has triggered off this undercover struggle. The meeting was of a specially summoned *ad hoc* committee of the International Council of Scientific Unions which had been asked to report on the scientific value of an extension of the current geophysical activity in the Antarctic for a further year or more. The suggestion had originally been put forward at an IGY executive meeting last year and after rather a checkered history, was referred back to the International Council of Scientific Unions (the parent body of the IGY Special Committee) for consideration.

Purists maintained that an extension of the "Year" in one area only would be meaningless since the current programme in the Antarctic is geared to simultaneous worldwide measurements. Nevertheless the February meeting has given a verdict in favour of at least a further five years work in the area after December 31, 1958, the end of the IGY. Immediately the decision had been announced, the Russian delegate declared his country's intention to remain in the Antarctic after the IGY was over to continue scientific investigations. A few days before, the Americans made it clear that some of their bases were to be made permanent. The complication is that the current Soviet expedition is operating in Antarctica by courtesy of the Australian Government in whose territory their stations are situated, on the understanding that they leave at the end of the IGY. The United States, which has made no Antarctic claims so far, is working in British-claimed territory. The countries with well-established claims to Antarctic territory: France, Norway, Britain, New Zealand, and Australia, have (with the exception of New Zealand) maintained stations with active research programmes for several years before the IGY started and all plan to continue operations at these indefinitely, without prompting from the ICSU committee. So, to the realist, it appears that the *ad hoc* committee's resolution does little more than provide a good excuse for the "big two" to continue in the area.

On the other hand, there is not the slightest doubt that Antarctica deserves a great deal more study and that it will take years of work to discover some of its many secrets. It is a little difficult to know therefore what other conclusion this committee could have come to. But having come to it, the matter should not be left there. The only permanent and satisfactory solution is to make Antarctica an international scientific area.



Specially drawn for DISCOVERY by J. F. Horrabin.
(*h* is Planck's constant.)

MAX PLANCK (1858–1947)

Max Karl Ernst Ludwig Planck was born at Kiel in Germany a century ago on April 23, 1858. Though he died at Göttingen just over a decade ago on October 4, 1947, as a scientist he already ranks with such giants as Galileo and Newton. His discovery in 1900 of the "doctrine of elemental quanta" completely changed the face of physics and profoundly influenced all the allied sciences from chemistry to biology. The son of an eminent jurist, he studied mathematics and physics at Munich, and subsequently at Berlin under Gustav Robert Kirchhoff and Hermann von Helmholtz, and in 1879, at the early age of twenty-one, graduated Ph.D. at Munich with a dissertation on the second law of thermodynamics. In 1885 he became *extraordinarius* at the University of Kiel, and four years later succeeded his old teacher, Kirchhoff, in the chair of theoretical physics of the University of Berlin. During his long tenure of office he made some of the greatest discoveries in physics since those of Newton. His quantum theory made clear many hitherto unsolved problems such as the specific heat of solid bodies and the effects of photoelectricity. It elucidated the law of the periodic system of elements and paved the way for Niels Bohr's quantum theory of atoms.

It is difficult to explain Planck's quantum theory in a few words and in non-mathematical language. The laws

of classical dynamics being unable to account for the distribution of radiant energy from a so-called "black body" between the various wave-lengths in the radiation's spectrum, Planck advanced the ingenious theory that the energy emitted by a "vibrator" was parcelled out in integral multiples of a very small fundamental unit or "quantum" of energy. This theory, accepted slowly at first since it meant a declaration of the inadequacy of classical physics, grew beyond all expectation till it dominated the whole system of modern physics.

Planck was elected a member of the Prussian Academy of Sciences in 1894, and in 1912 its permanent secretary. He was awarded the Nobel Prize for physics in 1918 "in recognition of the merit he had attained for the development of physical science by his discovery of the elemental quantum". He was president of the Berlin Kaiser-Wilhelm-Gesellschaft from 1930 to 1933. This society was dissolved in July 1946 and replaced on February 26, 1948, by the Max Planck Society for the Advancement of Scientific Research. Planck was elected a foreign member of the Royal Society in 1926 and honorary member of the Royal Society of Edinburgh in 1937. On the occasion of his eightieth birthday he received an unusual "present" when astronomers "gave" him a small planet which they named "Planckiana".

Before deciding to make physics his career, Planck had seriously thought of becoming a composer. A brilliant pianist, he was able to play many of the musical classics from memory. He and Einstein were not only scientific colleagues, but also great friends. Both loved music, and they often played chamber music together, with Planck at the piano and Einstein on the violin. Planck was also a keen and hardened mountaineer and climbed the Ortler, which is more than 12,000 ft. high, when well over sixty years of age. He believed in the value of having real holidays, which he usually spent in the Alps in lonely mountain villages. Deeply religious, he always felt that science could contribute to the moral and spiritual development of mankind.

During the Nazi régime, in his capacity as president of the Kaiser-Wilhelm-Gesellschaft he approached Hitler on one occasion on behalf of some of his Jewish colleagues, only to be met with a tirade against the Jews. That men like him carried on with their scientific pursuits while holding themselves aloof from politics was a constant embarrassment to the government, as is evident from an extract from Goebbels's diary: "It was a great mistake that we failed to win science over to support the new state. That men such as Planck are reserved, to put it mildly, in their attitude towards us, is the fault of Rust (the Minister of Education) and is irremediable." One of Planck's sons was executed in July 1944 on suspicion of having been implicated in the plot against Hitler.

Planck as a man was modest, simple, kindly, and hospitable. He held definite views and expressed them frankly. As a lecturer he was extremely popular, for he spoke in a quiet, audible, and pleasant voice without notes. Among his colleagues he inspired respect akin to reverence. He died a few months before his ninetieth birthday. His portrait appeared on two German stamps, in 1950 on the occasion of the 250th anniversary of the Berlin Academy of Sciences, and in 1952 in a series of "Famous Berliners".

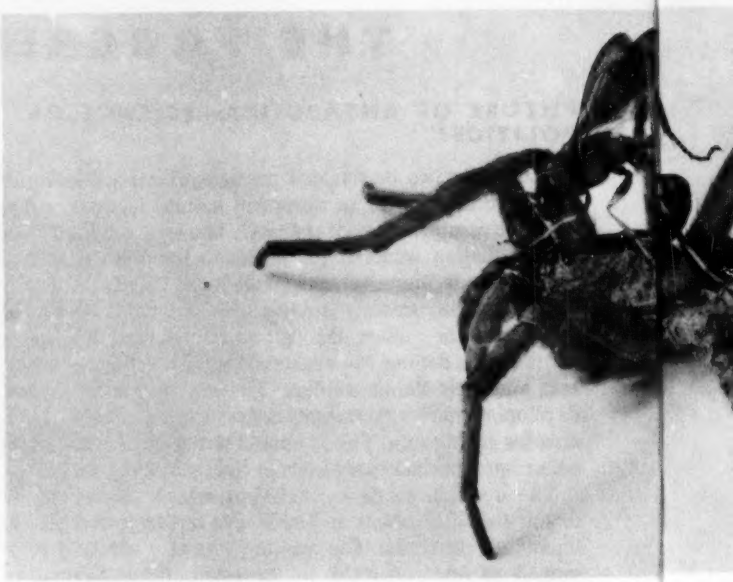


FIG. 1. Mud-daubing wasp attacking a spider.

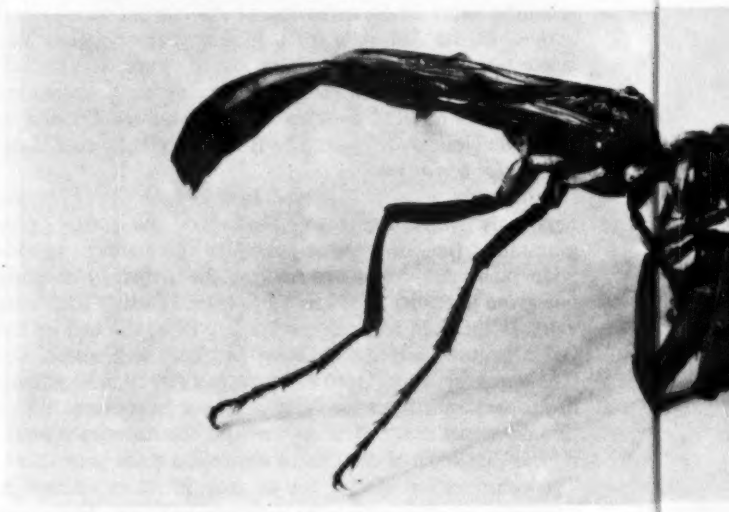


FIG. 2. Dragging a spider towards the nest.

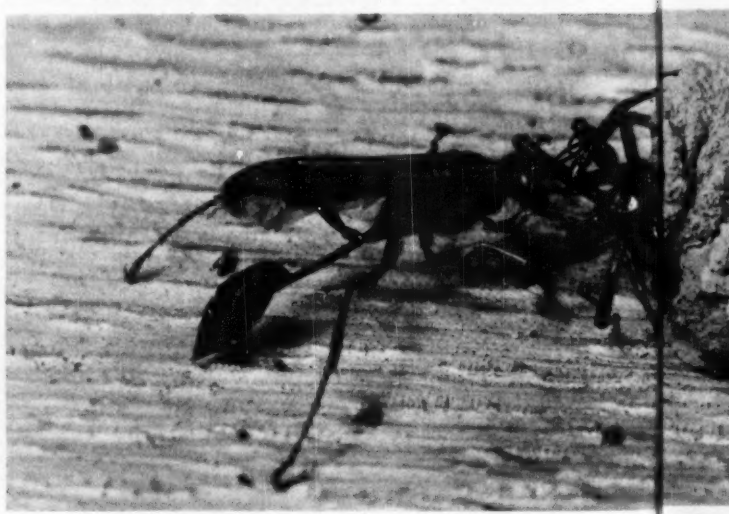
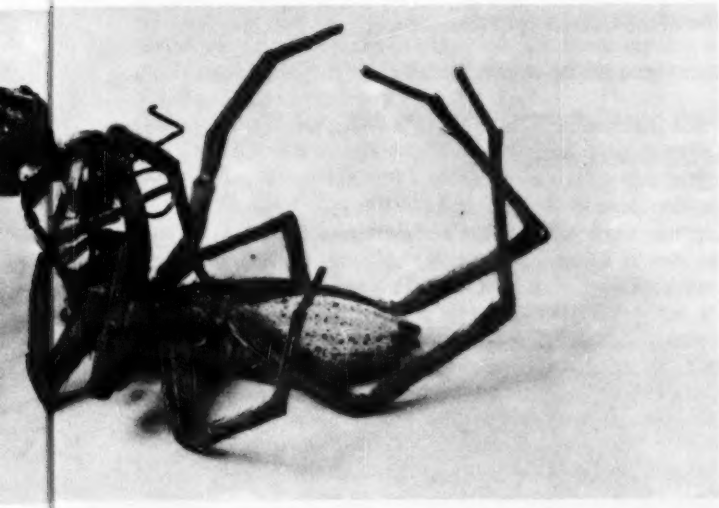


FIG. 3. Placing a spider within the nest cell.



(Photographs by Ross E. Hutchins)

THE BEHAVIOUR OF HUNTING-WASPS

Solitary wasps are of particular interest to the biologist, not only on account of their complex behaviour but because they illustrate intermediate stages in the development of social habits. Most insects abandon their eggs as soon as these have been laid, but social wasps and bees, like ants and termites, care for them and tend the larvae after they have hatched.

The gregarious habit which prevails in some insects has nothing to do with social behaviour. Locusts become gregarious when they assume the migratory phase, and ladybirds mass together before hibernating—but never is there any association of parent and offspring, the criterion of true social behaviour.

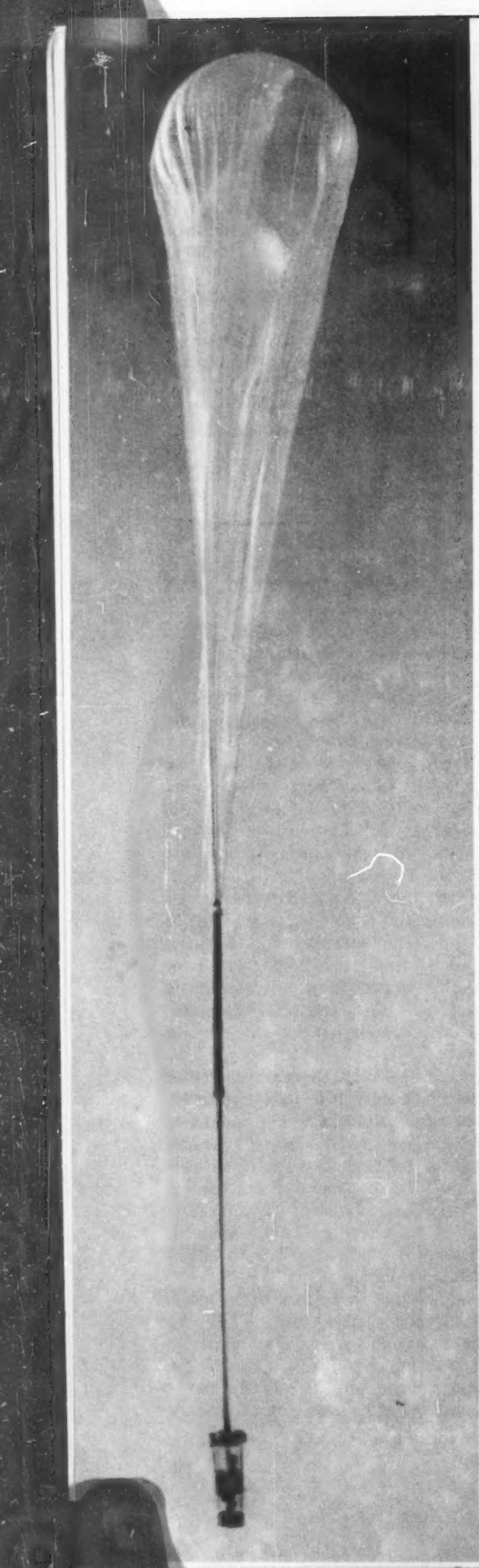
Solitary wasps can be divided into three groups, according to the type of reproductive behaviour they show. The least advanced are those that catch and paralyse a spider, then hide it and look for a suitable nesting-place. Sand-digging and mud-daubing wasps always make a nest consisting of a number of cells, before catching an insect or spider. After several victims have been stored, an egg is laid and the cell closed. Again the mother has no contact with her young.

In the third group, however, the eggs may be laid in empty cells and food provided when the young have hatched. This involves quite a feat of memory on the part of the parent. New food is brought when the larva has eaten its first supply; but when it begins to spin a cocoon the mother leaves it and does not return. In some species the female may feed her young with chewed fragments instead of whole prey. In these wasps, therefore, the mother does come into contact with her offspring and it is from insects possessing a similar degree of parental instinct, but not, of course, from any existing species, that social insects are believed to have evolved.

Hunting-wasps of the family Sphecidae are slender insects with attenuated "waists" that are often little stouter than a fine bristle. Their prey consists mostly of caterpillars, grasshoppers, or spiders. Mud-daubing species of the genus *Sceliphron*, illustrated in the accompanying photographs, are common in the warmer regions of the globe. They build their nests from mud or clay, often in human dwellings.

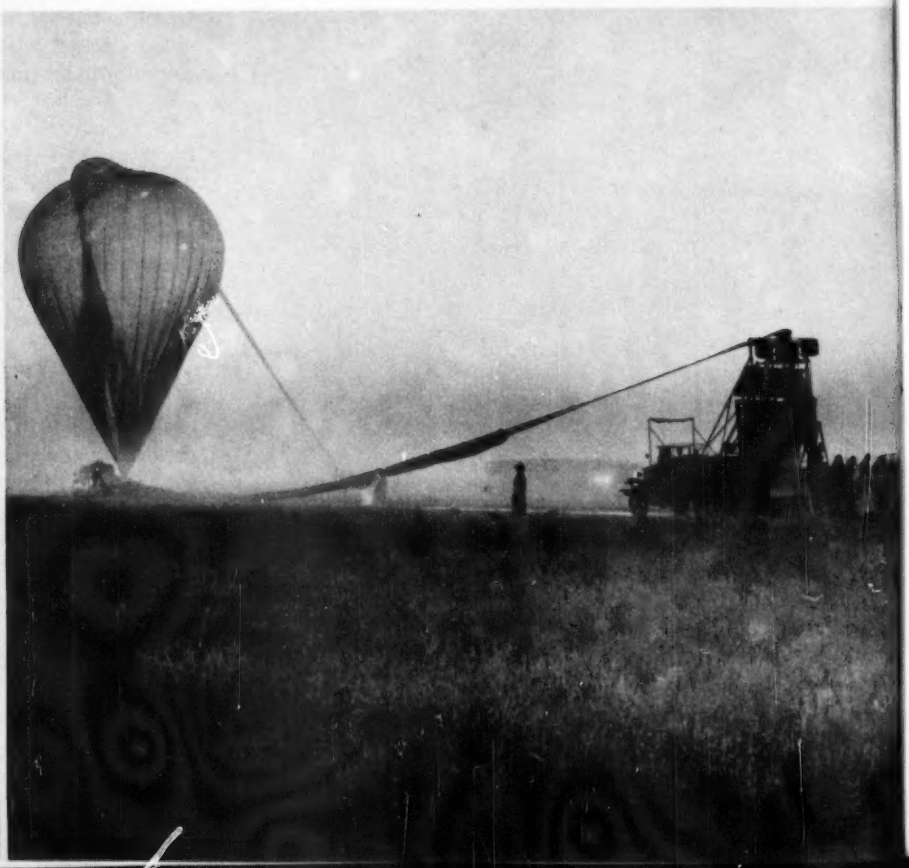
Having constructed a shapely cell, the wasp plasters it over with a rough coating of mud. If the cell is removed, leaving only its circular base, the female will proceed to encase this as though the whole cell were still present. This is because instinctive behaviour consists of an hierarchy of instinctive acts. The completion of one element of the behaviour pattern releases the next, which, in turn, provides a stimulus for the subsequent acts. Although pliable within limits, instinctive behaviour seldom allows an act to be repeated out of sequence.

The mud-daubing wasps prey on spiders, but it seems to be a matter of indifference whether these are killed or only paralysed, for the wasp's poison acts as an antiseptic which keeps the prey fresh for several days. Certainly the wasp is no clairvoyant surgeon with an intuitive knowledge of the internal anatomy of its prey, as some authors appear to think!



OPERATION STRATOSCOPE

The clearest photographs yet taken of the Sun were by means of a telescope launched on a giant unmanned skyhook balloon as a part of the U.S. Office of Naval Research project stratoscope. The stratoscope balloon was equipped with a special light-sensitive pointing mechanism and a powerful, specially designed 12-in. astronomical telescope coupled to a 35-mm. motion-picture camera. The project was carried out by the Upper Air Laboratory, Department of Physics and the Research Laboratories of the University of Colorado, and the Perkin-Elmer Corporation, among others. In this context the Note on Balloon-borne Solar Telescope, DISCOVERY 1957, vol. 18, No. 5, p. 182, should be consulted.



DISTURBED PREGNANCIES

The hypothesis that children born after a serious illness during the pregnancy might suffer mental and physical defects was given support when the distinguished Australian eye surgeon, Sir Norman Gregg, discovered that German measles contracted during the pregnancy could have such effects on the unborn child. However, such speculation did not take into account the possibility of influence from trouble or stress other than physical illness. Bearing in mind the close relation between physical conditions and mental stress, Dr Stott, a psychologist working at Bristol University, conducted an investigation* into the causes of mental handicap and retardation. His conclusion is that because emotional upsets had been overlooked in the past, the actual harmful influences had remained unknown in most cases.

During his investigation Dr Stott made inquiries about a wide range of disturbing emotional factors which might have been present during the pregnancy. He found that these were many times more frequent in the months before the birth of retarded children than of normal children. Not all cases of mental handicap and retardation are due to disturbed pregnancy, of course, but Dr Stott reports a definite relationship between the course of the pregnancy and the health of the child.

Experiments with animals had already shown that malformations could be induced in the offspring by subjecting the females to unfavourable conditions during the pregnancy. Dr Stott has observed that, with human beings, where some trouble or stress in the pregnancy was reported, the children were sometimes physically affected as well as mentally retarded. Some of them had such malformations as defective palates, webbed toes, or an extra finger at birth; others suffered from bronchitis, pneumonia, digestive and skin complaints, or were generally ailing as babies. On the other hand, children whose mental retardation seemed to be due to some illness *after* birth were, in general, physically healthy.

The probability that the offspring of a disturbed pregnancy will be mentally retarded, however, is very small. According to Dr Stott's calculation, it would be between one child in thirty and one in forty. The chances of its being malformed or spastic are somewhat less. In fact, physical illness in the offspring is by far the most common result of disturbed pregnancies, as Dr Stott's parallel study of mentally normal children showed. About one in three of the offspring of disturbed pregnancies had had some fairly serious illness before the age of three, but this was true of only one in ten children born after a healthy, undisturbed pregnancy. In either case, the chances that the child's health will be permanently impaired are small.

Thus, a mother whose child is suffering from some early serious illness may be reasonably certain that he will recover as he grows older. Furthermore, since mental handicap is shown to be the result of very special events and circumstances during the pregnancy, a mother who has had one handicapped child need not fear of having a second, provided she is happily settled and is physically healthy and strong.

* Reported in *Lancet*, 1957, May 18, p. 1006.

THE SCOTTISH RESEARCH LABORATORIES MUTUAL ASSISTANCE SCHEME

"Where can I get immediately a 5-ft. length of aluminium bar 1 in.×1 in.? The best delivery date from suppliers is seventeen weeks."

"I have been trying for several weeks without success to obtain a short length of two-core cable, each core separately sheathed and insulated, with an overall diameter of less than 3 mm."

"We are thinking of buying a reflectance spectrophotometer but would like to have the opportunity to examine and discuss performance with other laboratories who have operational experience with instruments of this type."

These and many other similar problems are dealt with in Scotland through a unique scheme which embraces all Government, Government-sponsored, academic, agricultural and medical research organisations. The Scottish Research Laboratories Mutual Assistance Scheme was started eighteen months ago as an experiment by DSIR. It is based on the experience of the local DSIR representative who found that the "old-boy" network, dealing with problems like this, had severe limitations, particularly in relation to contracts between laboratories in different fields of research. Now the medical research man in Glasgow can be put in direct contact with a chemist in an agricultural institute in Aberdeen, or a biologist in Millport with an engineer in Edinburgh, should they have a common interest in a specific material, laboratory technique or laboratory equipment. Redundant and second-hand equipment can be found or disposed of through the scheme, which is operated by one man with part-time clerical assistance.

A record has been made of the location of all important or unusual laboratory apparatus and research facilities and, as inquiries are received, they are checked against the records and wherever possible a direct answer is provided. Inquiries which cannot be dealt with in this way are published in a Bulletin which is issued as and when necessary. Each member laboratory (there are now over 160) has a Mutual Assistance Scheme correspondent who undertakes to read the Bulletin and initiate action on inquiries to which he thinks his own laboratory might contribute some useful information.

Basically the scheme is designed to encourage co-operation between research organisations irrespective of their field of work. It is concerned with the materials, the apparatus, the techniques, the know-how, the tools of the scientist; not with the results of his work. There is no form-filling or formality about membership. The only qualifications required are research facilities located in Scotland and a willingness to co-operate fully in the scheme. There is nothing spectacular about the service. It is of marginal interest only to any single laboratory, but when one is looking for a short piece of stainless-steel tubing or practical advice on the latest type of centrifuge, it is good to know that through the MAS one can contact at least 160 people who might be able to help.

The scheme is now being expanded to include the laboratories of industrial firms. Although MAS is not "Research Equipment in Cotton-wool" (DISCOVERY, 1957, vol. 18, No. 8, p. 329, it is certainly worthy of imitation outside Scotland. A copy of the *Bulletin* can be obtained from E. Martindale, 20 Walker Street, Edinburgh, 3.

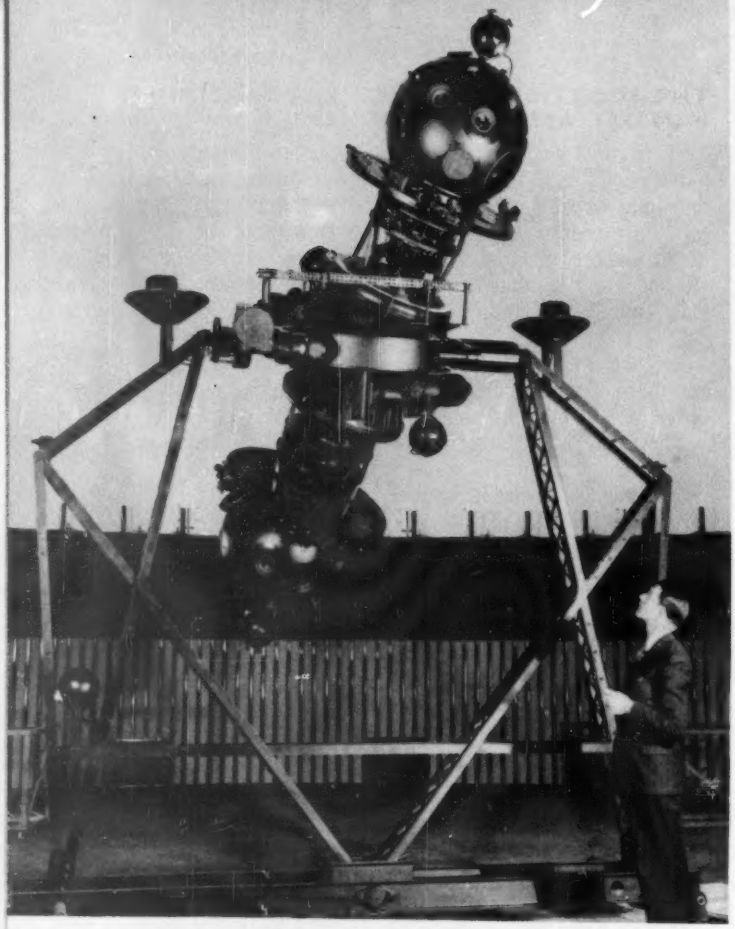


FIG. 1. Dr H. C. King, Narrator-in-Chief at the London Planetarium, looks over the Zeiss Projector.

FIG. 2. The dome of the London Planetarium.

THE LONDON PLANETARIUM

The London Planetarium opened its doors to the public in March; DISCOVERY* was the first to give a detailed description of it in English and since then other articles† have appeared. It is just over three years ago that plans were announced for London to have a planetarium at long last. As is well known, the modern planetarium houses complex and expensive equipment for the portrayal of the night sky able to be seen from any part of the Earth's surface. Now the building with its distinctive copper dome is a landmark to Londoners. It is situated on the site of Madame Tussaud's cinema which was bombed in the early days of the blitz. The entrance is in the Marylebone Road almost adjoining Baker Street Station.

The copper-covered outer concrete dome is of shell construction‡ and this protects an inner hemisphere of aluminium sheeting perforated with millions of minute holes to obviate undesirable acoustic effects. The hemisphere has a diameter of 67 ft. with a matt white surface on to which an artificial sky is projected with all the beauty of the starry sky of nature. The horizon of the London Planetarium is made with silhouettes representing the London skyline. St Paul's dome, the towers of Westminster, Greenwich Observatory, and the cranes of dockland are clearly distinguishable.

The auditorium with comfortable seating for 547 persons is at first-floor level. At the centre the platform of a vertical lift mechanism supports the £70,000 Zeiss universal projector which projects speeded-up versions of the movements of the heavenly bodies against the inside surface of the dome. The platform is actuated by four electric motors which operate through worm-gears, and the projector when not in use may be lowered from the auditorium to repose in a glass cage in the foyer of the building at ground-level.

The main projector is a triumph of engineering and optical skill. The dumb-bell central assembly supported on a steel latticework carriage is 13½ ft. in length. The globes for the stars of the northern and southern hemispheres lie at opposite ends of the dumb-bell. These are able to project 8900 stars of the 3rd to 6th magnitude. The brightest stars of the 1st to 2nd magnitude are projected from forty-two special projectors fitted to muffs on the star globes of the dumb-bell. All of these stars are correctly graded in brightness and so spaced on the artificial sky that their configurations conform to those seen in nature.

The central bar portion of the dumb-bell houses complex gear and link mechanisms for moving the Sun, the Moon, and the five naked-eye planet projectors. These mechanisms embody ingenious adaptations of uniform circular motions for the planets; the design is such that a planet appears in the planetarium sky with an accuracy of position within one degree.

The Sun projector has built-in fitments for the portrayal

* DISCOVERY, 1956, vol. 17, No. 12, p. 507.

† "Zeiss Planetarium for London", H. C. King, *Engineering*, March 1, 1957, pp. 258–61. "From the Aratus Globe to the Zeiss Planetarium", H. Werner. (Translated from the German by A. H. Degenhardt, Verlag. Gustave Fischer, Stuttgart, 1957.)

‡ "Projection Planetarium and Shell Construction", Prof. Bauersfeld (James Clayton Lecture). *Proc. Inst. mech. Eng.*, 1957, vol. 171, p. 75.

of the aureole or halo seen best as the Sun rises and sets; the zodiacal light, a faint lenticular glow orientated along the ecliptic—and the *Gegenschein* or counter-glow, a diffuse patch of light diametrically opposite the Sun.

The Moon projector incorporates a concave mirror about which rotates a closely fitting hemispherical cup. This gives the Moon a variable terminator which thereby exhibits its phases. In the earlier projectors the Moon's disc was quite plain; in the London projector Zeiss have included means for presenting the Moon's disc complete with maculae.

Provision is made on the dumb-bell for ancillary projectors able to throw out on to the dome surface a realistic Milky Way, well-known nebulae, star clusters, variable stars such as Algol, Mira Ceti, Delta Cephei; constellation names, the ecliptic, and the main reference grids based on the celestial equator.

A separate projector is installed to show the heliocentric motions of the planets. It is possible by this means to show the solar system as it would appear from a point beyond the orbit of Saturn.

A separate constellation projector using three easily effected rotary movements (in azimuth, altitude, and position angle) enables the lecturer to show constellation figures superimposed on the stars.

The northern star globe will eventually be equipped with a comet projector able to reproduce the appearance and geocentric motions of the great Donati comet of 1858. Further devices will show meteor showers and eclipses of the Sun.

Presentations will be given in the morning, afternoon, and evening of each weekday, and on Sunday afternoon and evening only.

The morning presentations will be of particular interest to the younger age groups. A scheme to be highly welcomed—for astronomy is not generally taught in our schools.

The evening and week-end presentations will be designed to appeal to adult audiences.

The prices of admission are not high. The charge to children is two shillings in the morning. In the late afternoon the price will be three shillings and in the evening a maximum of only four shillings.

The London Planetarium is the thirty-third of its kind (that is, based on the work of Dr Bauersfeld and made by Zeiss), but is the first to be erected in the Commonwealth. At long last this country which has produced some of the world's greatest astronomers has a planetarium worthy of its high traditions.

In the capable hands of Dr H. C. King this versatile instrument will without doubt provide enjoyment and instruction for very many people. In an age when more and more men are needed for scientific pursuits it is heartening to see a private venture prepared to spend over £300,000 to such laudable ends. All with a love for astronomy and associated scientific interests will hope that the London Planetarium becomes a centre for the dissemination of astronomical knowledge to the lay public and a centre for specialised courses to cater for the more specific needs of educationists and the training of young people.

FIG. 3. Zodiacal light formed by the reflection of sunlight on fine cosmic dust in the vicinity of the Earth's orbit. *Left:* Hyades. Pleiades. *Right:* M31. Andromeda nebula.

FIG. 4. Constellation Projector showing the rotatable reflecting prism for positioning its image in altitude.

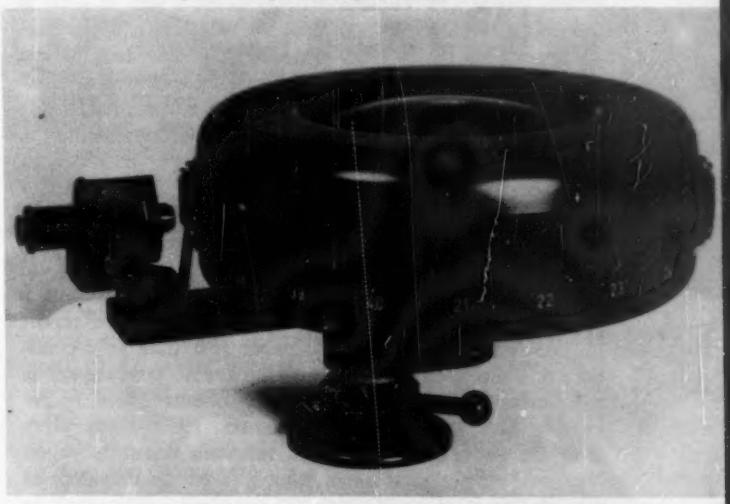


FIG. 5. Dr King at the control panel of the huge Zeiss Projection instrument. The dome of the Planetarium represents a hemisphere of the night sky. The instrument projects speeded-up versions of the movements of the heavenly bodies against the inside surface of the dome. Around the base of the dome a frieze represents the London skyline.

A BELATED *FESTSCHRIFT* FOR N. I. VAVILOV?

It is interesting to see a paper by the late Academician N. I. Vavilov appearing in the *Journal of the U.S.S.R. Academy of Sciences* (Изв. акад. наук СССР, сер. биол., 1957 No. 5, 590–600). It is entitled "The Mountain Agriculture of the North Caucasus and the Prospects of Its Development", and there is an editorial footnote to say that it is "an unpublished article by N. I. Vavilov (1887–1942) appearing to mark the 70th anniversary of his birth, on 28th November 1957". This is the celebrated Russian geneticist and plant-breeder, formerly President of the Academy of Agricultural Sciences until he was overthrown and replaced by T. D. Lysenko in 1938. The little that is known of his subsequent history has been given in a Royal Society Obituary Notice (1954), which, incidentally, gives the year of his birth as 1885. It appears that he was arrested in 1940 as a "British spy" (those were the days of the German-Soviet Alliance) and that he died under unknown circumstances in 1942, at about the same time as he was elected a Foreign Member of the Royal Society.

The paper now published helps to fill a gap in what is known of the last phase of Vavilov's career. It is the preliminary report of an expedition to the Caucasus, where he spent July to September 1939 as leader of one of eight sections, investigating agriculture, horticulture, and fruit-growing in the highland regions. He recommends the introduction of new and improved varieties of grass and of new breeds of sheep, and he considers that productivity could be increased if animals were grazed on the hills in the summer and allowed to winter lower down. He also reports having made extensive collections of *Triticum* varieties, an interesting wild rye, and some particularly promising strains of barley, and promises a further report on these at a later date. The paper is written in a confident and authoritative style, and makes no concessions to the curious ideas of his victorious opponents. It must have been written shortly after September 1939, three years after the publication of his last recorded scientific paper. Vavilov had accepted an invitation to act as President of the 7th International Genetical Congress at Edinburgh in 1939, but a letter from him refusing to attend was received just before the Congress opened. This letter was dated July 26 and addressed from Moscow, though it now seems that on that date he must have been in the Caucasus.

Vavilov was one of the very greatest geneticists, unrivalled in his particular field of the genetics and systematics of crop plants. Appointed head of the new Academy of Agricultural Sciences by Lenin in 1921, he built up a large and efficient organisation which was just beginning to produce its most valuable results when it was destroyed, and Vavilov discarded while at the height of his scientific career. Then for the next fifteen years all that he had achieved was ridiculed, the fundamental basis of his work was rejected for ideological and not scientific reasons, and all his followers and pupils were proscribed.

Things have been changing in Russia during the past few years and the science of genetics is no longer condemned. It is a bit late now for a *Festschrift*, and this modest birthday reminder is perhaps the best that could be done for a memorial. It is at least something that the Academy again feels free to publish a contribution from one of the most distinguished of all its members.

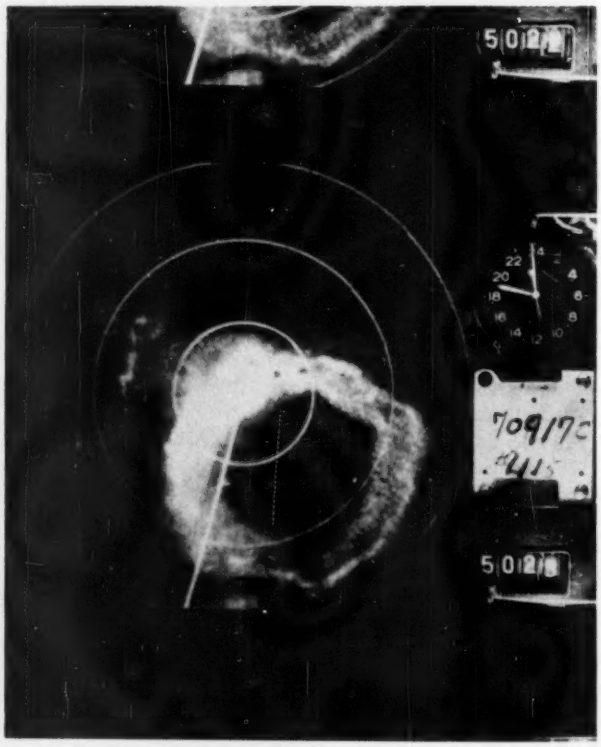


FIG. 1. Photograph taken inside the eye of hurricane Carrie from one of the B-50 (U.S.A.) research aircraft.

FIG. 2. Radar picture of a B-47 (U.S.A.) radarscope; the aircraft was flying at 35,000 ft. The light-coloured ring represents the wall cloud of hurricane Carrie on September 17, 1957. The diameter of the eye in the radar picture is approximately 40 miles.

HURRICANES LESS MYSTERIOUS?

There is a distinct possibility not only of detecting the formation of a hurricane, but of predicting its path for several days with more reliability than has been true in the past.

This is revealed by R. C. Gentry and R. H. Simpson of the Weather Bureau's National Hurricane Research Project at West Palm Beach, Florida, U.S.A., in a report just issued by the Smithsonian Institution. With the aid of relatively new research tools (radar and storm-plunging reconnaissance planes) meteorologists now are making considerable progress in understanding the basic mechanisms of the great storms.

But, the report stresses, possibility for eventual control is probably many years in the future, although "experimentation during the last two or three years leads one to believe that ultimately it will be possible to make forecasts of [hurricane movements] . . . with such accuracy that it [should be] possible to alert coastal areas forty-eight hours in advance".

Notable among the recent findings concerning hurricanes, the report points out, are:

1. Most of the heavy rain in these storms (second greatest factor in loss of life and property damage) occurs in rain-bands that spiral towards the centre of the storm. Between these bands rainfall is relatively light and near the outer edges there frequently is no rain at all.

2. Most hurricanes have several centres which may, or may not, coincide. In the past only one centre, or "eye", has been postulated. There is the centre of wind circulation, the point of lowest air pressure, and the point around which the spiral rain-bands, or "cloud streets", rotate. Location of these centres may differ by as much as twenty miles. Winds are much stronger in some quadrants, the rain area extends out farther in some, and there are irregularities in cloud structure. But all three of these elements tend to be concentrated along spiral bands.

3. Hurricanes frequently move along an irregular path which oscillates back and forth across the relatively straight path which storms are believed to have followed in the past. Some of these oscillations have a relatively short period of three to six hours, and some a period of twelve to thirty-six hours.

It now has been well established, the report says, "that the primary energy source for hurricanes is the warm, moist, tropical air in the areas where the great storms form. As this air converges towards the storm centre it accumulates additional latent and sensible heat from the warm ocean surface. Near the centre the air rises rapidly and most of its water vapour is condensed to water, thus releasing great quantities of latent heat. In some way a small quantity of this heat is converted into energy for driving the hurricane winds, but the mechanism for transforming the energy remains pretty much . . . a mystery."

In the past it generally was believed that the great storms developed only when there was excessive heating at some place in the tropics. The heated air, it was thought, would rise and cause clouds which developed into showers. The more intense the heating the heavier the showers; finally a storm covering a wide area was formed.

Close examinations have shown, however, that hurricanes form in areas where there is very little change in sea surface temperatures over great distances. Showers form over tropical oceans during much of the year and very few of them ever develop into such violent storms.

Thus the real genesis of the hurricane remains essentially unknown, although various theories have been developed. It is now clear, however, that hurricanes form only over the tropical oceans where the water temperature is at least 80°F and where showers are occurring. The higher ocean temperatures are essential for heating the air until it is buoyant and able to hold a sufficient quantity of water vapour.

But also, the report states, it is necessary to have some pre-existing disturbance in the normally steady trade-wind circulation of the tropics. An object of the present studies is to determine the causes and nature of such a disturbance.

POLIOMYELITIS VACCINE

C. L. GREENING, M.R.C.S., L.R.C.P.
and H. J. PARISH, M.D.
Wellcome Research Laboratories, Beckenham, Kent

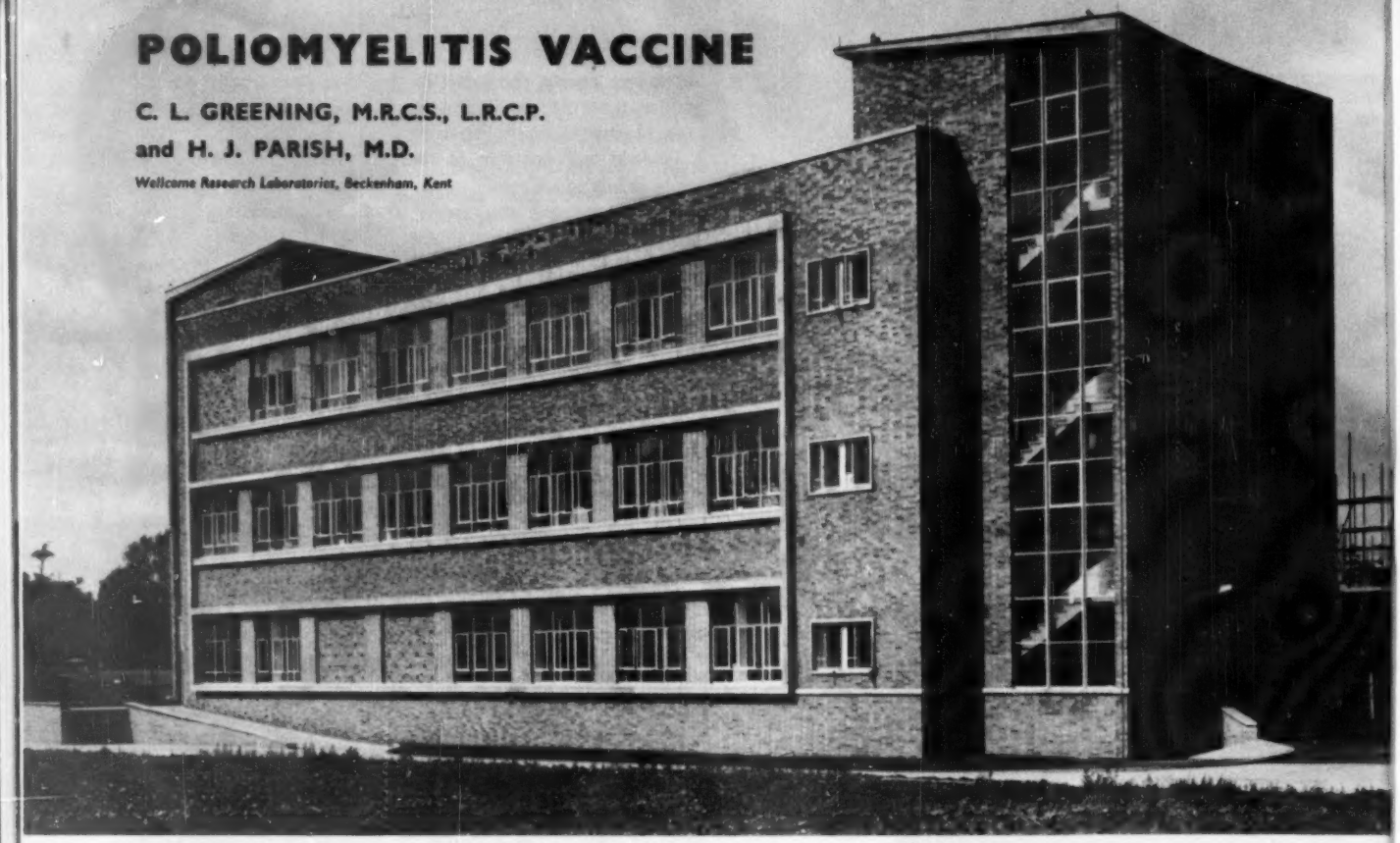


FIG. 1. Poliomyelitis Vaccine Production Building, Beckenham.

(All photographs were taken by E. A. Jones, photographer to the Wellcome Research laboratories. The illustrations are the copyright of the Wellcome Foundation.)

The preparation of a new type of vaccine against a virus disease such as poliomyelitis is a major undertaking that requires collaboration between expert teams—not only virologists, but architects, engineers, and building contractors. Modern techniques call for a considerable background of knowledge and skill, and the expenditure of large sums of money on premises and equipment. In this article a short description is first given of the Poliomyelitis Vaccine Production Building which was brought into use in January 1957 at the Wellcome Research Laboratories at Beckenham, Kent. Next, the method of preparation of the vaccine ("Polimylex") is discussed, including the thorough testing during and after processing in order to ensure the safety as well as the potency of the product. The final section deals with some aspects of the clinical use of poliomyelitis vaccines in Britain and overseas.

THE PRODUCTION BUILDING

When the Board of the Wellcome Foundation decided to manufacture poliomyelitis vaccine, scientists, architects, and engineers visited certain up-to-date laboratories in North America and Europe, and prepared plans for suitable premises and equipment to produce up to 4 million doses of vaccine a year. After the granting of an Industrial Development Certificate by the Board of Trade, planning permission for a new building was sought and obtained from Beckenham Borough Council and the Kent Planning Authority at Maidstone. The architects appointed were Messrs Waterhouse and Ripley, and the main contractors Holloway Brothers. Construction was started in September 1955 and was completed sixteen months later; it was not entirely uneventful as the laying of the foundations was delayed in the early stages owing to the wet and shifting subsoil, which necessitated piling and tanking. Altogether 151 piles were used, holes for which were bored to a depth of approximately 32 ft.

The building is 157 ft. long and 50 ft. wide, and is of three storeys, with a staircase and service lifts at each end, and central corridors 8 ft. wide. The partition walls between the rooms are so built as to be easily removable. The only internal vertical structural members that are immovable are the 1 ft. 6 in. × 9 in. columns in the corridor walls, spaced at 13 ft. 4 in. centres; all the construction is based on a standard module of 3 ft. 4 in. The cost of the building was £250,000.

In preparing plans for a project of this nature, a prime consideration is to ensure that much of the processing can be done under conditions of sterility at least equivalent to those required in surgical operating theatres. It is therefore necessary to keep the wall, floor, and ceiling surfaces of the working rooms as free as possible of essential and extensive services; at the Beckenham Laboratory these are hot and cold water, electricity, gas, compressed air, vacuum, drainage, refrigerating plant for the cold rooms, ventilation, heating (by means of auxiliary electrical ceiling panels), and air-conditioning. Special plant-rooms are provided at one corner of the building, and the services are distributed through a large space or void ("service" floor) above and

below each working floor. The internal height of the void over the central corridor is 6 ft. 6 in., so as to form an easy walk-way. The under-side which forms the ceilings of the rooms slopes up to a minimum internal height of 3 ft. This form of construction of the void enables routine maintenance and servicing to be carried out without "breaking" sterility during processing. Moreover, the services can readily be tapped at any point in the working area.

Great attention has been given to the virtual elimination from the laboratory suites of exposed pipes, ducts, drains, and other objects which are apt to collect dust and dirt. In addition, many rooms are air-conditioned, that is, they are supplied with clean air filtered through a series of materials of a decreasing degree of porosity so that finally it is bacteria-free; it can be heated or cooled as required; use has been made of air-pressure gradients to protect sterile rooms; and separate air-conditioning plants for individual sterile areas are installed to prevent cross-infection. For obvious reasons a strict discipline is imposed on the movement of staff from one suite to another.

Because of the need for segregation, three lifts have been provided and are allocated to "clean" and "infected" operations to suit the process.

A final point of some importance is that the internal arrangements of the building are sufficiently flexible to meet the ever-changing requirements of scientific production and research.

Two further buildings for work on virology are under construction at Beckenham and will together cost about £450,000. One will be used for research and development on new as well as existing virus vaccines, and the other for the production of the vaccines. These twin buildings are sited close to the poliomyelitis building and will provide some 50,000 sq. ft. of laboratory space.

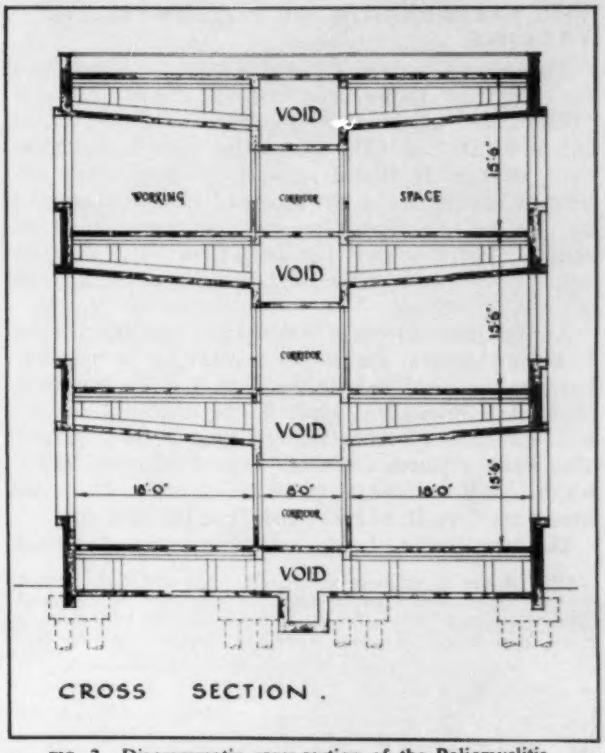
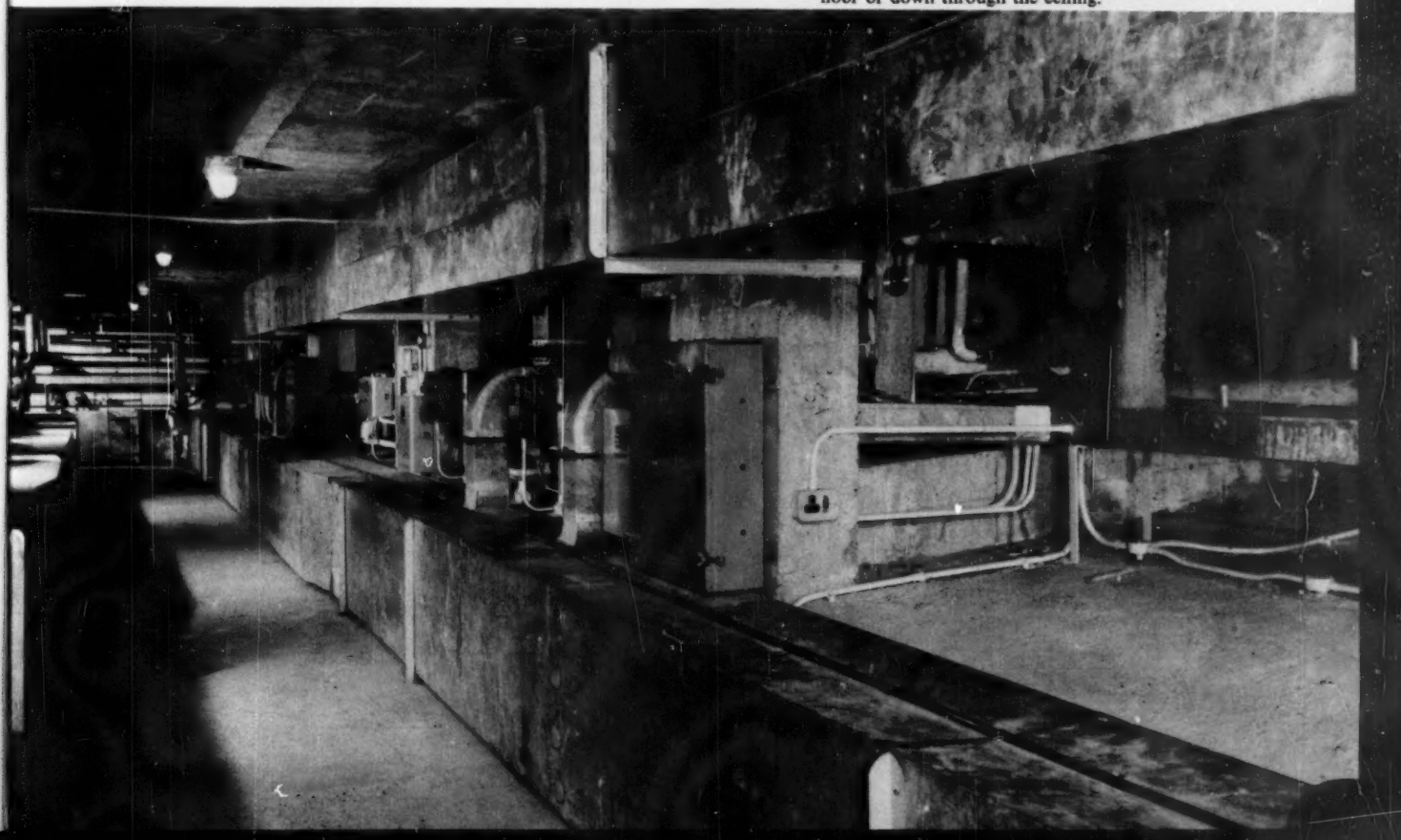


FIG. 2. Diagrammatic cross-section of the Poliomyelitis Production Building.

FIG. 3. Voids such as this between each floor of the building enable all services to be fed to the working rooms either up through the floor or down through the ceiling.



THE PREPARATION OF POLIOMYELITIS VACCINE

The vaccines made by different manufacturers in Britain are what are known technically as "inactivated" or "killed", and are based on the type developed in the U.S.A. by Dr Salk. The inactivating agent is formaldehyde, used in its diluted solution, formalin. Early experience in America in the spring of 1955 demonstrated the need for considerable improvements, especially in the matter of excluding surviving, living virus. More stringent testing was put in operation, and the safety of the material is now unquestioned.

All three known types of poliomyelitis virus are included in British vaccine. The strains selected are of relatively low virulence, and include the Type I strain Brunhilde (Enders) or Brunenders, which has been reduced in virulence (primarily for monkeys) by passage in tissue culture. This strain replaces the more virulent Mahoney strain which is still included in American vaccines. The other strains are Type II, M.E.F.-I and Type III, Saukett.*

The three strains of virus are grown separately on the cells of kidneys taken from healthy monkeys: kidney tissue is used on account of the good yield of virus obtained. The supply of poliomyelitis vaccine obviously depends a good deal on the availability of monkeys' kidneys, and Britain is importing about 1500 animals a month from India to meet the need. Most of the monkeys, which now cost approximately £15 each, yield the kidneys, each monkey providing from about 700 to 2000 doses of vaccine; some of the monkeys, as will be seen later, are used for testing the product.

As the virus is inactivated by treatment with formaldehyde for a period of twelve days after it has been cultivated on kidney cells, it is no longer capable of giving rise to the disease. At the same time it is rendered inert by formaldehyde in such a way as not to destroy its immunogenic activity. It is still able to stimulate in the human or animal body the production of antibodies, estimation of which will give some measure of the potential resistance induced by the vaccine against an infection with the live virus of poliomyelitis.

Filtration through a Seitz filter is carried out both before

* The names of micro-organisms are frequently derived from the laboratories where they are first isolated, from the names of patients, or from the names of research workers. "Enders", a Nobel Prize-winner, was the research worker who in 1949 first showed that poliomyelitis germs could multiply on cells other than nervous tissues. "M.E.F." stands for Middle East Forces during World War II. "Saukett" is the mis-spelled name of a patient named Sarkett.

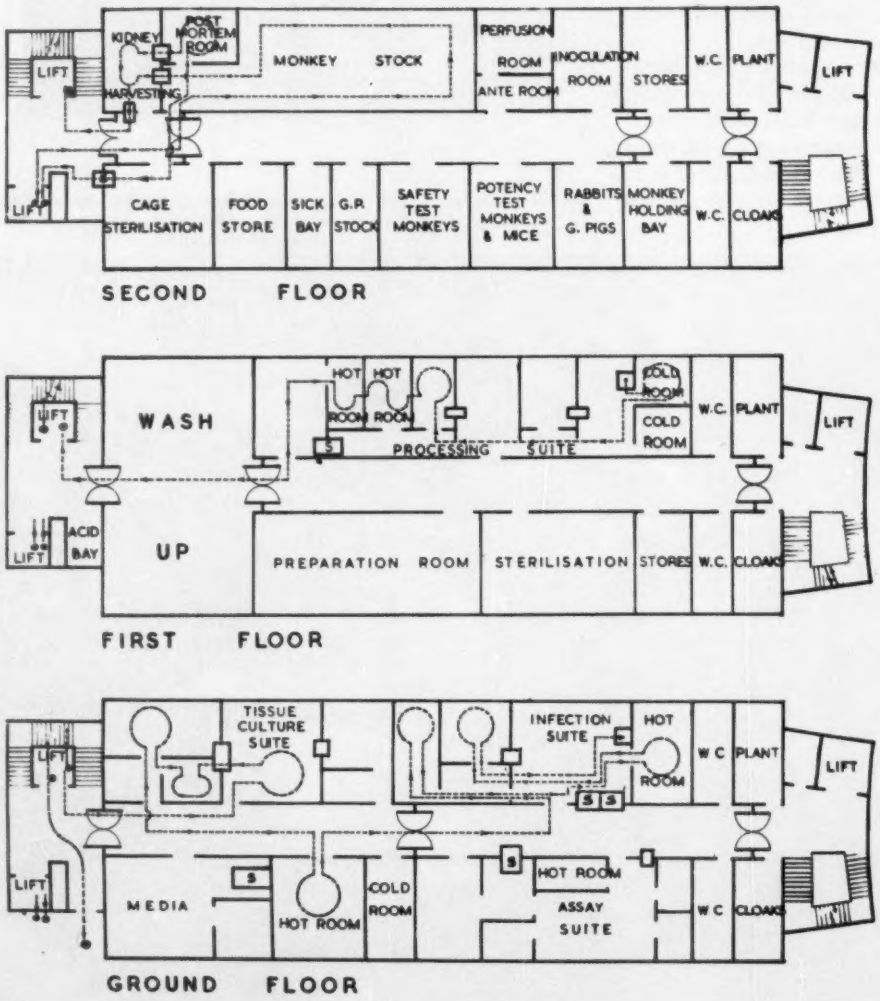
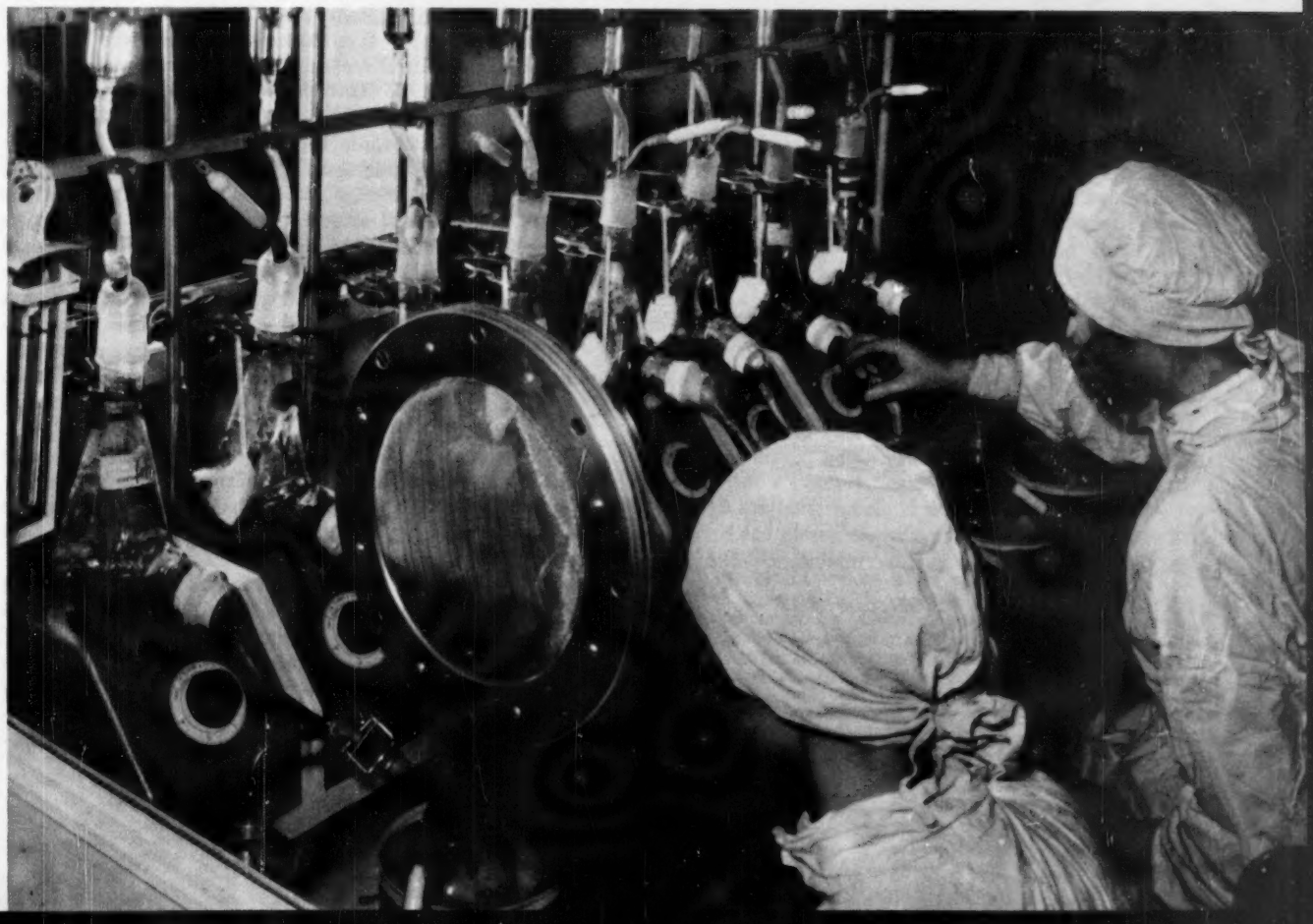


FIG. 4. Flow chart illustrating the manner in which materials used for Poliomyelitis Vaccine production pass from suite to suite.

FIG. 5. Changing medium prior to refeeding tissue-culture cells.

FIG. 6. Trypsinisation of monkey kidney.



and during inactivation with formaldehyde. This ensures the removal of particulate matter in which virus clumps might lurk and remain inaccessible to the chemical. On the completion of the twelve days inactivation period, any residual formaldehyde in the Seitz-filtered suspensions is neutralised by sodium metabisulphite. Equal quantities of the three types of inactivated virus are mixed to make a trivalent vaccine: each batch of the mixture normally contains about 300,000 doses. The final product contains 0·01% thiomersal as preservative and 0·07% of the disodium salt of ethylenediamine tetra-acetic acid (EDTA) as stabiliser.

LABORATORY TESTS FOR SAFETY AND EFFICACY

The process of making a vaccine at once safe and effective is most complicated and calls for technical knowledge and skill of a high order at all stages. Safety as well as potency are foremost in the minds of manufacturers. Larger volumes of test samples are examined than was customary before the 1955 experience in the U.S.A.

It is considered insufficient to conduct safety tests only on the completed vaccine containing the three types of inactivated poliomyelitis virus, and samples are taken at several stages of manufacture. When a single strain pool of one type of poliomyelitis vaccine has been produced, it is not only tested for bacterial sterility, but its potency is determined by inoculation of guinea-pigs, and its safety is demonstrated by examination of very large volumes by tissue-culture techniques. Until such time as single strain pools of each individual type of vaccine have satisfactorily passed all their tests, no such pool may be blended in the final trivalent vaccine. When sufficient quantities of individual single strain pools have been collected of each of the three types of poliomyelitis virus suspension, these are blended to make the trivalent vaccine, and large samples of this vaccine are then taken for safety test by tissue culture.

Once samples of the blended material have been taken for the purpose of carrying out the tissue-culture tests mentioned above, a preservative and a stabiliser are added to the vaccine, which is then put into ampoules. In addition to the ordinary tests for bacterial sterility and toxicity required by the Therapeutic Substances Regulations,* samples taken from the lots of vaccine in ampoules are tested for antigenicity by giving three intramuscular injections into monkeys at weekly intervals, after which the serum antibody content is estimated by its capacity to neutralise each of the three types of living poliomyelitis virus when added to monkey kidney cell cultures. These neutralisation tests are controlled by parallel titrations of standard type-specific antisera.

An additional safety test is also carried out by injection of vaccine into live monkeys whose serum has been proved to be free from poliomyelitis inhibitors. The monkey safety tests on the final vaccine are carried out by intracerebral, intraspinal, and intramuscular injection of vaccine into both rhesus and cynomolgus monkeys. Cortisone is administered to the animals every other day in order to increase their sensitivity to poliomyelitis infection. Nineteen days after inoculations, the safety test monkeys are killed, and intensive histological examination of the central nervous system is made, sections being cut from seven brain and twelve cord levels in each animal.

As a check on the findings of the Manufacturing Laboratory, each batch of vaccine is similarly tested individually by the National Institute for Medical Research, London, on behalf of the Licensing Authority. The aim of the regulations is to ensure (*a*) absence of residual live virus; (*b*) absence of contaminating virus; (*c*) absence of bacteria and moulds; and (*d*) presence of adequate antigenicity. The results of the rigorous testing by the manufacturer and the Licensing Authority are compared, and finally, great importance is attached to the consistency of the findings with successive batches, as an indication that there is a satisfactory margin of safety.

The whole process of manufacture and testing of a single strain pool consisting of several batches takes about six months.

SOME CLINICAL CONSIDERATIONS AND RESULTS

The virus of poliomyelitis is about 1/50,000 mm. in diameter and is one of the smallest known. It is present in the central nervous system, and sometimes in nose and throat washings as well as in the excreta of patients and many contacts. When infection takes place there is a brief early phase in which the virus is circulating in the blood; the aim of immunisation is to stimulate the production of immune agents so that extension of the virus from the blood to the central nervous system may be prevented.

The Ministry of Health, London, has recommended a primary course of two injections each of 1 ml. with an interval of at least three weeks between them. The vaccine may be given intramuscularly or subcutaneously at the discretion of the doctor. The Americans recommend three doses, the first and second being spaced by two, or preferably four to six weeks, and the second and third by not less than seven months. It is claimed that the latter interval, which is relatively long, is important as it ensures higher titres of antibody and better protection. The completion of the course before the expected seasonal increase in incidence is recommended. It is too soon yet to make firm recommendations regarding subsequent boosting doses later in life.

Reactions after the injection of poliomyelitis vaccine have been negligible since the spring of 1955, which may be partly due to the fact that the material contains no serum or other protein to which children may have been previously sensitised.

Smallpox vaccination and other types of immunisation should not be given within a fortnight of poliomyelitis vaccination, according to a recommendation of the Ministry of Health in 1956. For immunisation against tuberculosis (with BCG) or yellow fever vaccination the intervening period might well be three to four weeks. The preliminary results obtained in the United States and else-

* *Therapeutic Substances Act.* The potency, sterility and absence of toxicity of sera, vaccines, prophylactics and certain other therapeutic agents such as insulin and pituitary extract are controlled in Great Britain by regulations issued by the Ministry of Health under the Therapeutic Substances Act (Therapeutic Substances Regulations, 1952. H.M. Stationery Office). Manufacturers of such products work under a licence issued by the Ministry and such licences may be revoked if the requirements of the Act are not complied with.

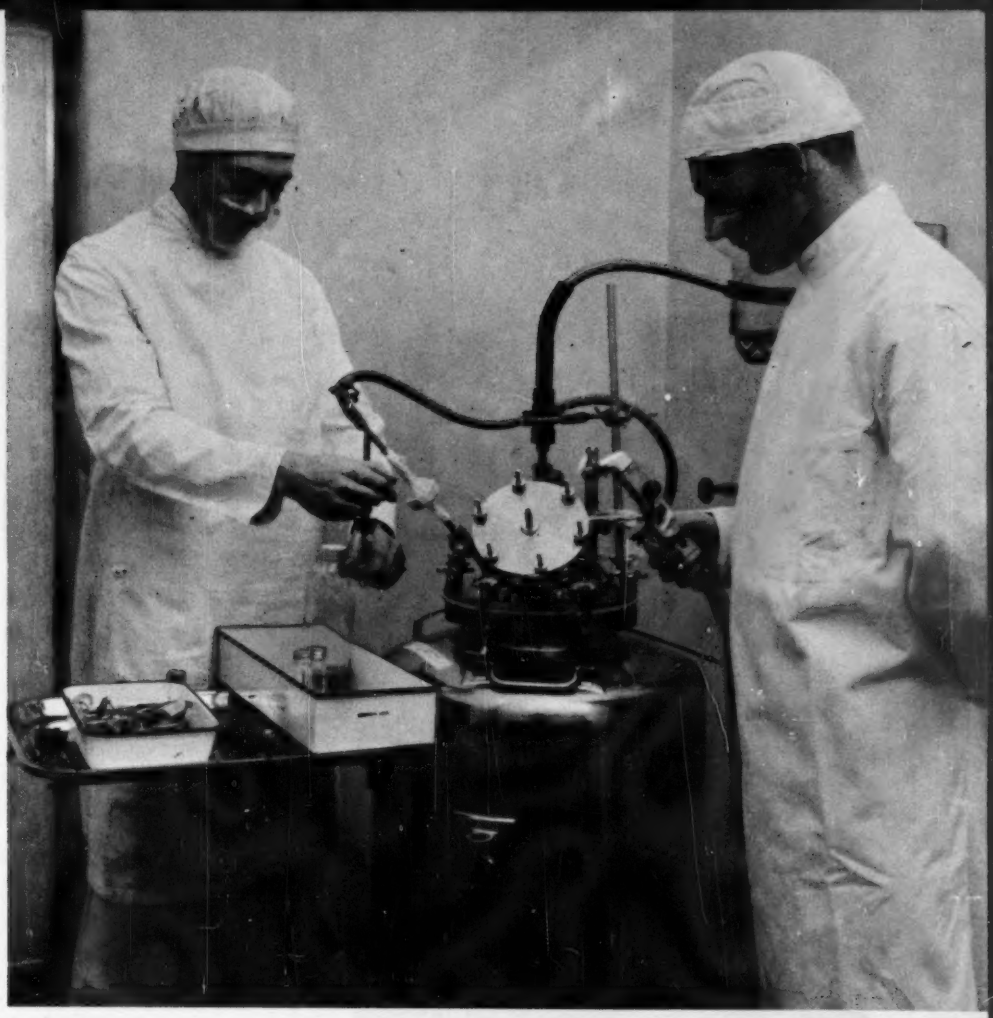


FIG. 7. Sampling the vaccine during the inactivation process.

where with a quadruple prophylactic (poliomyelitis vaccine *plus* diphtheria-tetanus-whooping cough prophylactic) have been encouraging, but much further work is necessary. There is an obvious advantage in immunising infants against four important diseases in the early months of life: the number of needle-pricks required is significantly reduced.

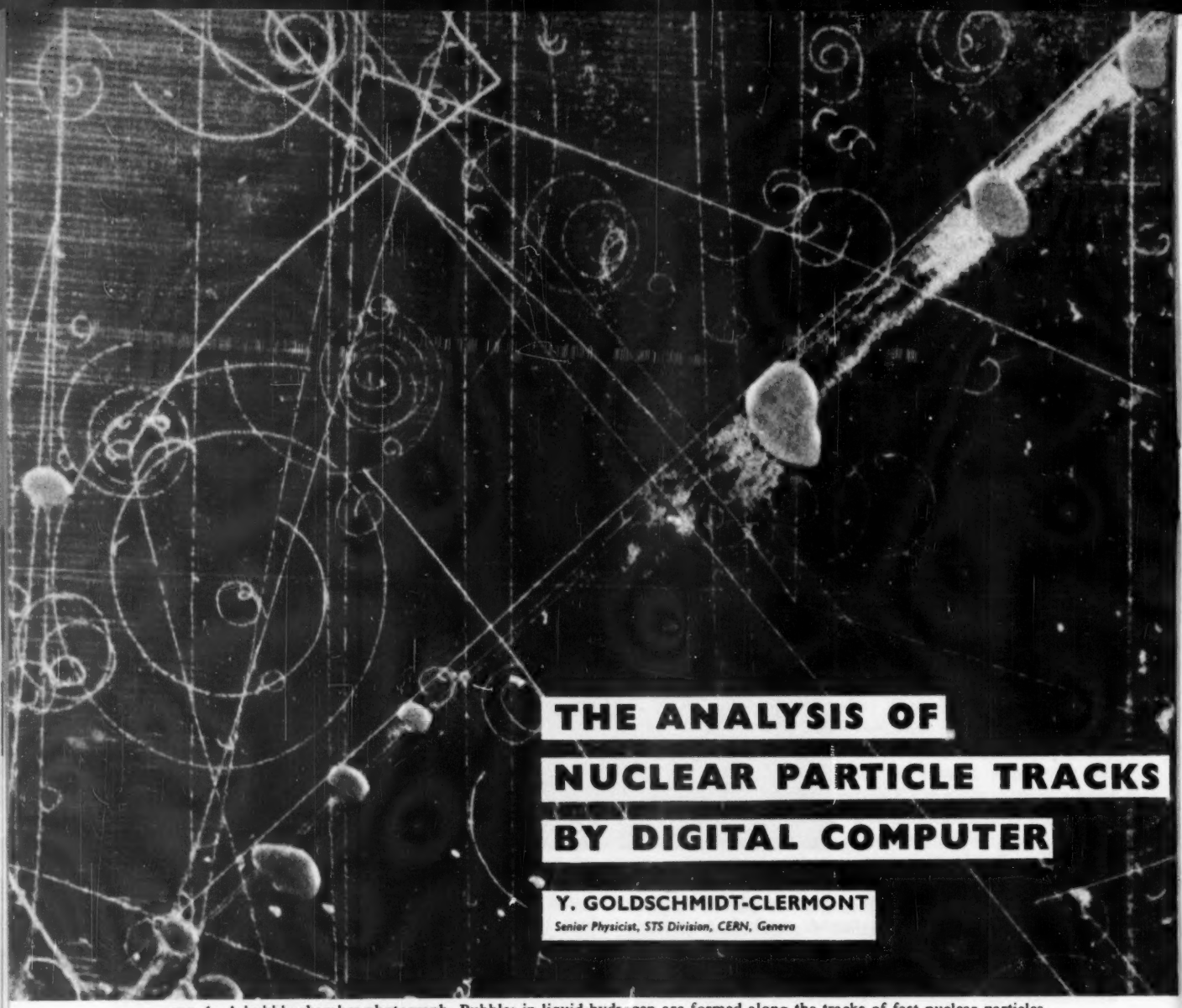
American preparations of poliomyelitis vaccine have reduced the incidence of paralytic poliomyelitis to between one-fifth and one-quarter, compared with the unvaccinated; this has been achieved after a two-injection schedule. With good American vaccines, the incidence may be reduced to less than one-tenth, after three doses. According to the British Medical Research Council (*Brit. med. J.*, 1957, vol. i, p. 1271), British children aged 1½ to 9½ years, who were vaccinated with British vaccine, had an attack-rate of paralytic poliomyelitis in the 1956–7 season which was only one-fifth of that of unvaccinated children.

An editorial in a Canadian medical journal (*Journal of Public Health*, 1957, vol. 48, p. 482), mentions that there were 368 paralytic cases of poliomyelitis and 34 deaths in Canada in 1956, the five-year average being 857 paralytic cases. In the U.S.A. in 1957, there were 4130 cases in contrast with a five-year average of 22,168 cases. The Canadian Public Health authorities now endorse the administration of vaccine to all persons forty years of age and under and to all pregnant women. By November 1957, in the U.S.A. it was estimated that 5 million persons under forty had received one injection of vaccine, 25 million two injections, and 34 million three injections. However, an estimated 45 million persons (two-thirds adults) have received no vaccinations; this is a matter of grave concern to the American authorities.

The shortage of vaccine in Britain has restricted the number of doses injected and the age-groups selected for inoculation. In a circular (16/57) to local authorities, dated November 19, 1957, the Ministry of Health, London, has stated that poliomyelitis vaccine (formaldehyde-inactivated) will be made available before summer 1958 to all children under fifteen, to pregnant women, to doctors specially exposed to risk, to ambulance staffs and to the families of the last two groups. There are about 12 million children under fifteen in Great Britain, and during the course of a year, some 750,000 expectant mothers.

The new Poliomyelitis Building at Beckenham should contribute significantly to the success of a campaign to prevent paralytic poliomyelitis in this country. The evidence seems clear that vaccine prepared according to the prescribed Salk method and tested according to the prescribed safety and potency tests, is safe and of considerable value.

Mr R. L. Kennedy, Chief Engineer to the Wellcome Foundation Limited, kindly supplied the information in this article about the structural details of the Production Building.



THE ANALYSIS OF NUCLEAR PARTICLE TRACKS BY DIGITAL COMPUTER

Y. GOLDSCHMIDT-CLERMONT
Senior Physicist, STS Division, CERN, Geneva

FIG. 1. A bubble chamber photograph. Bubbles in liquid hydrogen are formed along the tracks of fast nuclear particles. (*Berkeley.*)

In their studies of high-energy nuclear phenomena, many physicists show a predilection for the instruments giving a visual picture of the particle trajectories, such as the cloud chamber, the nuclear emulsion,* and the bubble chamber. These types of apparatus, which are very valuable for cosmic-ray research, seem also well suited for the study of the complex events produced by the particle beams of the modern accelerators. A typical photograph (Fig. 1) shows, on a background of random droplets or bubbles, a number of criss-crossing rays, some belonging to the beam under study, others to stray radiation. By careful inspection the trained observer picks out of this maze a significant event, recognised by certain salient features, such as a sharp bend in a track, or a number of rays diverging from an apex. The view of the event will sometimes allow an immediate identification by some apparent characteristic. The view of the vicinity is useful for the detection of correlated phenomena, such as the decay of unstable particles. But a number of measurements and calculations must be performed to extract from the picture all the available information.

* Mostly because of the scale of the recording of the events, the nuclear emulsion presents a problem quite different from the other techniques, and is not included in the present article.

TRACKS OF NUCLEAR PARTICLES

Each track appears as a somewhat discontinuous string of droplets or bubbles. The trajectories of fast particles are approximately straight, or curved into helixes if the experiment is performed in a magnetic field. They show some random deviations, or multiple scattering, about these ideal shapes. Two or more simultaneous photographs are taken from different angles to give a measurement of depth. Each photograph is a conical projection of the spatial event, affected by several types of distortion, such as the imperfections of the camera lens and the refraction of the light on its passage through the chamber windows. The spatial reconstruction, including distortion corrections, is a rather straightforward but lengthy geometrical problem, usually

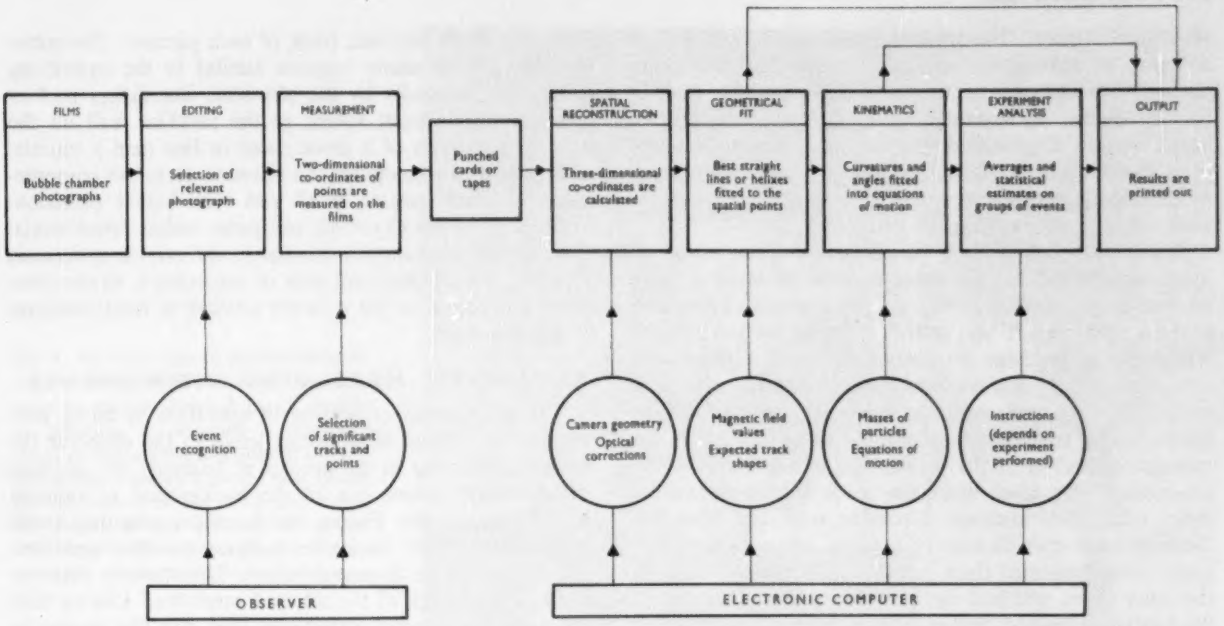


FIG. 2. Successful operations of picture analysis. The rectangles indicate the chain of operations performed by the observer and the computer in processing the data recorded on the photographs. The circles indicate the information added from outside the chain.

carried out by reprojection of the event in space on a movable screen, by graphical methods, or by numerical methods using suitable approximations. Through the strings of bubbles or droplets, straight or curved lines are drawn, their curvature and relative angles are evaluated, the bubbles are counted along the tracks, and the multiple scattering is measured. These operations extract from the photograph the required information: the bubble density and the curvature give a measurement of the velocity and the momentum of the particles. Together with the relative angles of the tracks, these quantities are inserted in the equations defining the kinematics of the event. Sometimes, the information does not identify the phenomenon uniquely. For instance, one or more neutral particles, not visible on the photographs, may be involved in the process. Several interpretations must then be tried and compared to the observations. The measuring accuracy is determined mostly by the size of the droplets or bubbles defining the trajectories; it is of the order of one part to 10^4, and the calculations must be carried out with the same precision. The complete analysis of one event by a trained physicist, using the conventional methods just outlined, takes an hour in favourable conditions, and often much longer. But one event brings only a small contribution to the knowledge of the complex high-energy phenomena; an improvement in their understanding can only result from the combination of large numbers of observations.

As used up to now, the visualisation techniques were adequate to deal with the rather rare nuclear interactions produced by the cosmic rays. When the bubble chamber is used in the beams of the modern high-energy accelerators, pictures can be taken at a fast repetition rate, and events subject to detailed analysis accumulate by the thousand. The conventional methods which were adequate to deal with the rare phenomena are discouragingly slow. Physicists are faced today with mountains of raw material that their conventional methods cannot process.

USE OF DIGITAL COMPUTERS

An access to this wealth of photographic information is under development in several laboratories. It is based on the use of the high-speed digital electronic computers to carry out the repetitive operations of processing. The successive phases of the picture analysis are summarised in Fig. 2. It is not clear at present that they could all be performed by a measuring instrument coupled to a high-speed computer. But there are very promising partial attempts, where the task is divided between a measuring instrument, the digital computer, and the human observer, with regard to the special abilities of each. In particular, it is sought to reduce progressively the role of the observer by confining his intervention where his judgment is essential, and to facilitate his task by giving him the easiest possible control of the measuring instrument.

The input equipment of the digital computers uses punched paper card or tapes, or magnetic tapes, on which the numerical information to be processed, and also the detailed instructions on the programme of operations to be performed, are recorded in code form. The information contained in the photographs must be translated into the computer code and recorded on the cards or tape. In the simplest cases, the measurements are carried out by conventional methods and their results are coded and punched manually. Appreciable gains in speed and reliability are made when the readings of the measuring instrument, instead of appearing on a dial or paper chart record, are given directly as coded punchings on tape or cards.

The nuclear physicist is, of course, not the only scientist facing the problem of reducing a large amount of

experimental data. The trajectories of guided missiles, of meteors, of natural or artificial satellites, of stars, are studied with instruments similar to those used on nuclear particle tracks. In several other fields, measuring instruments are now fitted with digital output, and many complex phenomena such as elastic stresses in flying aircraft, or oscillographic records of geodesic measurements, can be analysed in detail by electronic computers.

The careful preparation of the coded programme of operations performed by the computer involves a large amount of preparatory work, as each step must be written down in every detail, and coded. "The important thing to remember in machine programming," said a prominent expert recently, "is that machine computers are dumber than anybody." They make mistakes if instructions are faulty or incomplete, if some numbers turn out to be larger than the storage register, or of the wrong sign, and so on. But the programme of a given operation needs only to be written down once. For instance, a routine will start from the 2-dimensional co-ordinates of a point on a given photograph, and combining them with the information found on the other views, will find the 3-dimensional co-ordinates of the spatial point and evaluate the measuring errors. The same routine can be repeated on any number of points for each track. Another programme may be the geometrical fit of the best line, of given shape, such as a helix, through the spatial points, and the computation of such quantities as the direction of tangents to the helix at required points, and the radius of curvature. The same programme is used over and over again for each track of each picture. The entire procedure is in many respects similar to the operations performed manually by the physicist, but differs in four fundamental aspects; speed, as the machine will do the complete analysis of a given event in less than a minute; accuracy, as the computer can afford to carry out computations in much greater detail and with higher precision; reliability, as the electronic computer makes fewer trivial mistakes than the human calculator, and can use systematic checking procedures; and area of exploration, as the computer can afford to test a larger number of interpretations of a given event.

AUTOMATIC MEASURING INSTRUMENTS

The instruments at present in operation or being constructed in several laboratories leave to the observer the essential first step of the process of analysis: the selection of significant events out of the background of random bubbles and tracks. Future significant progress may result from an automatic device for carrying out this operation. This point will be discussed below. The operator observes a magnified image of the selected event, and follows with a pointer the relevant trajectories (Fig. 4). The successive positions of the pointer are translated in digital form by electromechanical devices and recorded on punched tape or cards. For instance, the pointer is moved by a precision mechanical stage, and the rotations of the driving screws are measured by a set of electrical contacts connected to the tape punch. It would be very tempting to use an entirely

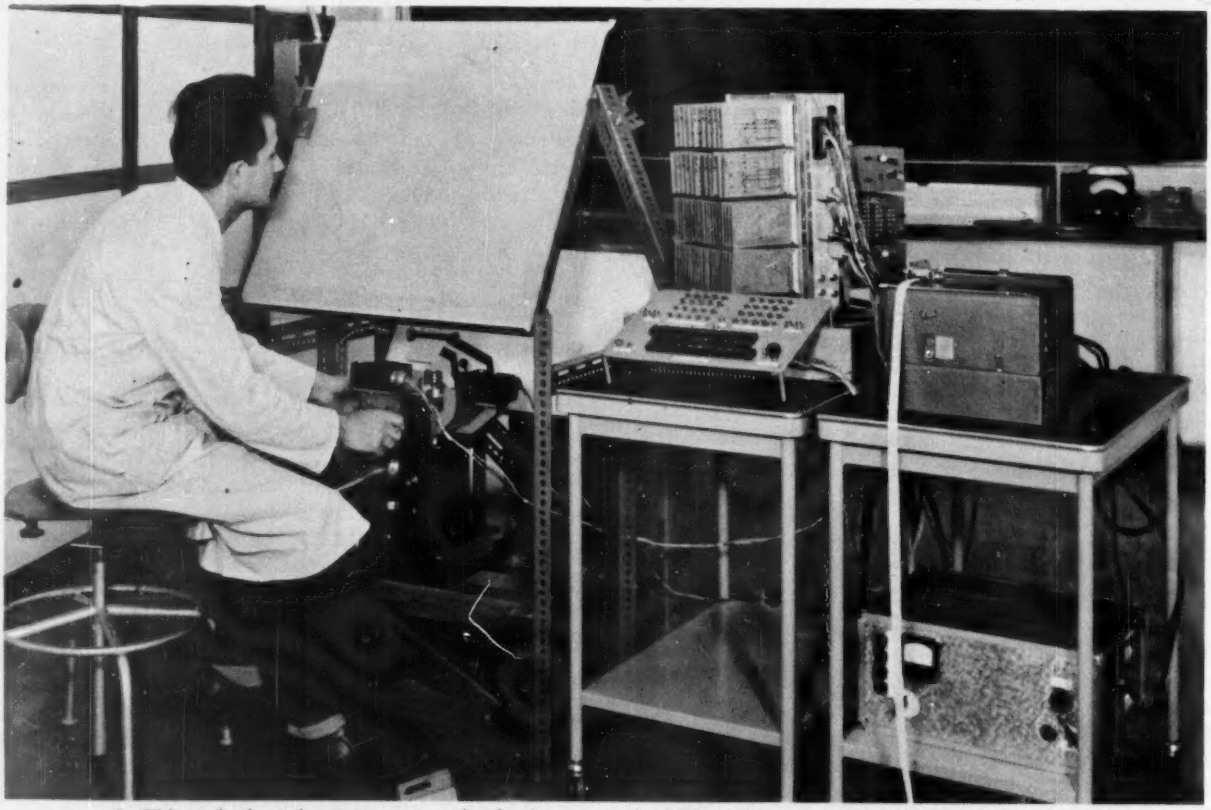


FIG. 3. This projection microscope, now under development in the CERN laboratories, projects a magnified image of the event studied on a screen. The successive positions of the image are measured and digitised by optical devices, coded by an electronic circuit, and punched on paper tape.

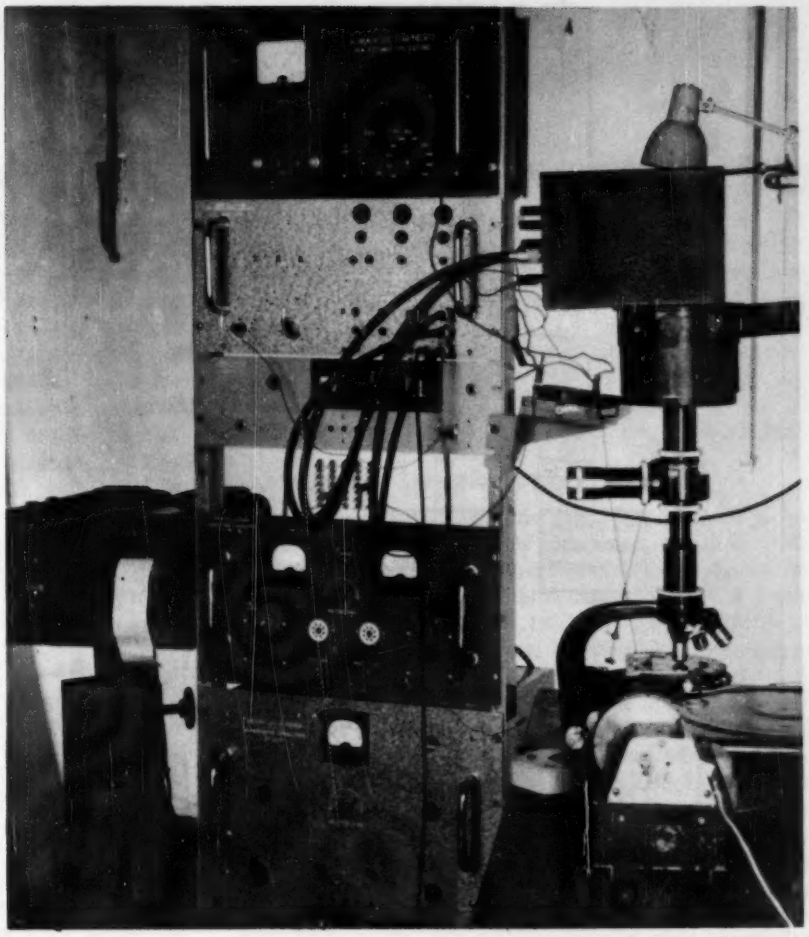


FIG. 4. An older type of digitised measuring instrument which has now been superseded by the one shown in Fig. 3. Similar in principle, it projected a magnified image of the event being studied on to a screen (not shown). Like the new model, the successive positions of the microscope are measured and digitised by optical devices (in the little bellows), coded by an electronic circuit and punched on paper tape.

electronic pointer position, by borrowing methods from radar and television, but in view of the rather high degree of precision needed, this appears to be technically difficult. The observer can be relieved from the tedious task of centring exactly the pointer on the bubble images: a small area around the pointer is explored by a simplified television scanner, giving an electrical signal proportional to the distance from the pointer to the track. This error signal can either drive a servo-mechanism to centre the pointer automatically, or be stored on the punched tape for interpretation by the computer. The signal from the television scanner could conceivably be used, in addition, to measure the bubble density and the multiple scattering. Thus the role of the observer is confined to two main tasks: the selection of the significant events, or editing, and the rough driving of a pointer along the relevant trajectories. Additionally, he will have to record on the tape, with a special typewriter, some identification number for the event and certain code signals calling for interpretative routines stored in the computer programme. With such instruments, the measurement of one event takes only a few minutes. More time may be spent on editing, if the scanning reveals significant phenomena in a fraction only of the photographs. As the electronic computing is appreciably faster, the punched record turns out to be a convenient intermediary storage, where a large number of results can be accumulated, to be processed in rapid succession at a later time, saving precious hours of computer use.

The instruments constructed by different laboratories vary in several technical details. Such parallel approaches, when compared, are of course extremely fruitful for the improvement of future instruments. For instance, the coincidence of the pointer with the tracks can be made on the 3-dimensional event obtained by reprojection of the image in space on a movable screen. It can alternatively be made successively on each of the 2-dimensional images; the spatial reconstruction is then made numerically by the computer. Each method has some advantages. The 3-dimensional measurement relies more on the special ability of the observer to observe a spatial image; each event is measured only once. The 2-dimensional approach seems to require more work, as the different views of the same event are inspected successively, but the automatic centring of the pointer is much easier to make technically, and relieves appreciably the task of the observer.

FURTHER DEVELOPMENTS

The instruments in use or under construction today can certainly be perfected in convenience, speed, accuracy, and reliability. But major advances may well arise in the form of the methods of automatic scanning, the instrument replacing the observer even in the essential first step of

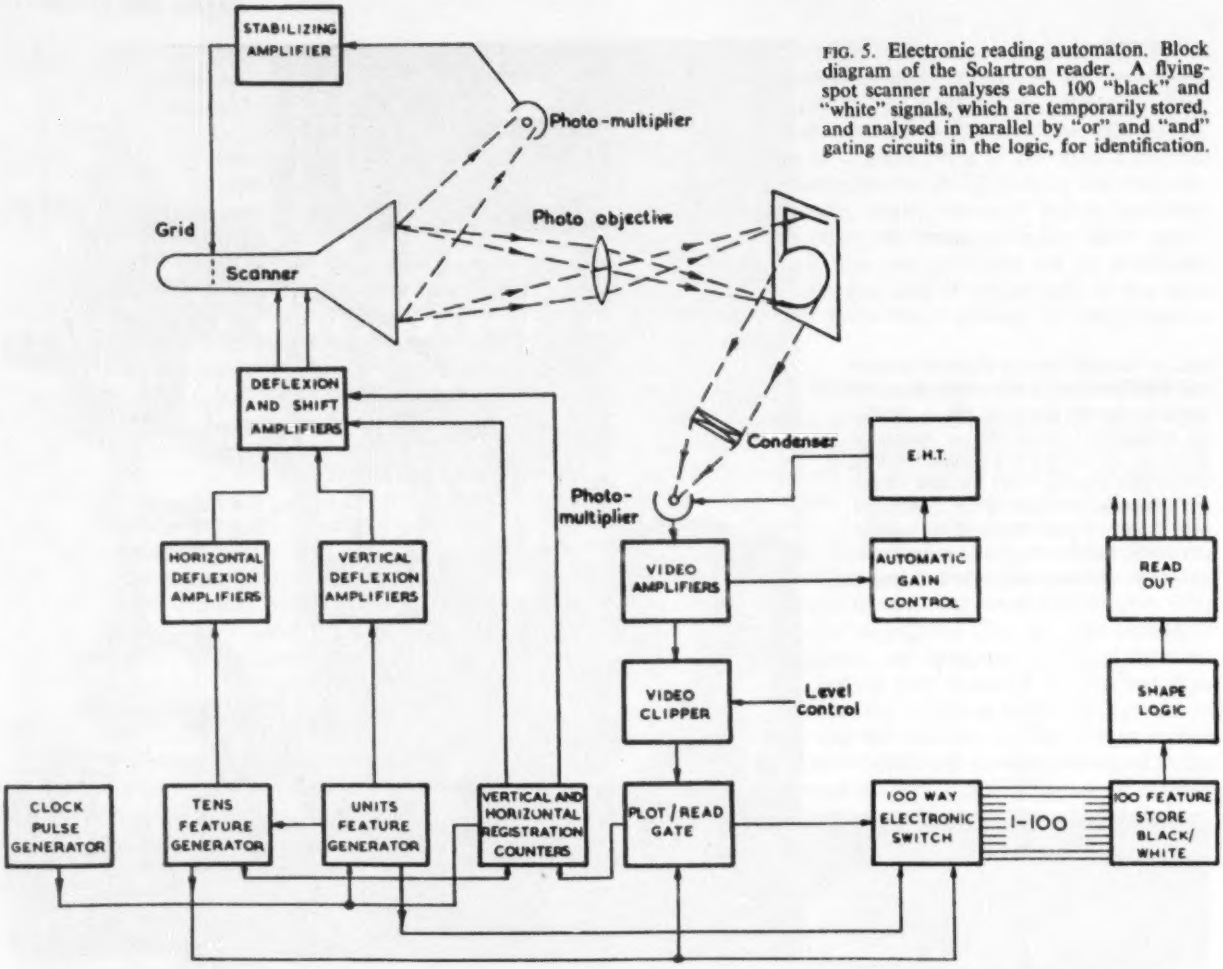


FIG. 5. Electronic reading automaton. Block diagram of the Solartron reader. A flying-spot scanner analyses each 100 "black" and "white" signals, which are temporarily stored, and analysed in parallel by "or" and "and" gating circuits in the logic, for identification.

picture analysis—the recognition of significant events. It would be indulging too much in science fiction to venture today to describe how this aim could be reached. It is instructive to examine, instead, some limited attempts in related fields, that could be precursors of the future instruments.

Several laboratories use automatic microscopes to recognise and count all the tracks of given direction in a nuclear emulsion (Fig. 4). Electronic signals resulting from the scanning of the microscope field of view are analysed in a computing circuit, where a count is registered when the co-ordinates of successive points verify a linear relationship. The counts found in successive overlapping fields covering the entire emulsion are so combined as to eliminate the multiple counting of long tracks, and to some extent, the spurious counts due to misinterpretation of background signals.

Another remarkable electronic device, developed by a British firm and now on the market, reads letters and figures on ordinary printed material, and translates them into digital form (Fig. 5). Each of the successive letters or ciphers is scanned individually and represented by one hundred electrical signals. To identify the symbol, the sequence of signals is checked against conditions stored in a computer memory. These conditions are flexible enough to allow the identification to be made in spite of random printing irregularities, or even wide variations in letter face.

The logical steps involved in the recognition of a straight line, or a letter, are simpler and less numerous, but perhaps not very different from those necessary to select some types of events on the chamber photographs. Larger amounts of information will need to be processed, and the checking conditions will be more complex, taking perhaps entirely new forms. That the human eye and brain are able to discriminate events so rapidly is a subject of wonder, and also of curiosity, as a more detailed understanding of their mechanism may yield fruitful ideas. All these examples can be used to show the fundamental necessity of increasing the coupling between the measuring instrument and the computer. The tapes or cards used at present, with their large storage capacity, are excellent intermediaries between the still rather slow measurement and the fast electronic computing. But they are serial in nature, allowing signals to be transmitted only one at a time, and they do not allow orders to be carried back from the computer to the measuring instrument which may be indispensable for the exploration of complex events. With the advent of transistor techniques, computers will become more widespread and specialised; it is to be expected that the future instruments for the evaluation of photographs will be connected directly, and by many channels, to their own relatively large computer.

THE SOURCES OF INVENTION

LORD HALSBURY

National Research Development Corporation, London

Reflect upon our remotest anthropoid ancestors and 20th-century man at his most sophisticated. The material difference between them lies in the paraphernalia surrounding the latter. The whole of this paraphernalia, lock, stock, and barrel, without a single exception, has been invented by someone or other at some time or other. Inasmuch as we are what we are in the material sense entirely by virtue of inventions, it is surprising how little objective study we give to the mentality and career of inventors. There are of course biographies of great inventors, either considered individually or grouped by subject matter; but the inventor and his invention regarded as elements of an evolving social fabric have not been studied as they deserved to be and he who would write of them must still pioneer. An attempt at objective study has been made by a group of Oxford economists, Jewkes, Sawers, and Stillerman, whose recent publication "The Sources of Invention"* is the subject of this article. It is impossible not to bless it as a much-needed contribution to thought or to be other than grateful for the fifty well-documented case-histories collected together in Part II. In addition to these merits it is also distinguished by common sense and a healthy scepticism about all that relates to the mythology of the subject. The Oxford team have no use for clichés or catch-phrases unless they can be substantiated in terms of facts. It is characteristic of pioneering studies that questions may be more important than answers. In this sense Jewkes and his co-workers, being economists, write as economists; the questions they pose are therefore conceived as an economist would see them. Which of state enterprise, monopoly, oligopoly, or free enterprise is the better patron of inventors? Does institutionalised research operate on a law of diminishing returns? Is the high incidence of inventions outside the pattern of institutionalised research an indication that all is not well with the latter? These questions are legitimate enough, though a sociologist or a technologist might ask others and might doubt whether the answers to the questions of the economists are of any great relevance. If the chemical industry is ever nationalised it will be for political reasons, not because Dr Ziegler was born in Germany rather than England and became an independent consultant rather than an employee of ICI.

THE INDEPENDENT INVENTOR

In writing of inventors it is helpful to choose one's words with care. The subject lacks any agreed nomenclature so that it is possible, as the Oxford workers do, to write of individual inventors as if, by implication, there were some other kinds. Now no corporate body, institution, or collective ever made an invention or ever will. Inventions are made by individuals only. On the principle that what is sauce for the gander is sauce for the goose, no monopoly or other collective ever killed an invention by neglect. No abstraction such as a monopoly can act. At most an individual can act in its name. Employment in or direction of a monopoly may engender a particular outlook; but it is still the outlook of an individual and not of a monopoly. In studying those who make inventions and those who break inventors, we are therefore studying individuals not abstractions.

Since this is acknowledged explicitly or implicitly by Jewkes and his co-authors, it seems a pity that they use the word "individual" throughout as the antithesis of "institutional". Surely "independent" is the true antithesis?

STATUS OF INVENTORS

A sociologist would be more concerned with the status of inventors rather than their location at the time when they invent. Part II of "Sources of Invention" gives fifty case-histories, but there are three cases from Part I which are sufficiently documented to have been included in Part II. These fifty-three cases describe important inventions made since 1900 and include only two pure and genuine "amateurs" with four borderline instances. Forty-seven out of fifty-three inventions appear to have involved professional scientists or technologists, and, of these, forty-four involved the cobbler sticking to his last. In only three cases were the inventors working outside their fields, for example, an engineer or physician working in chemistry (catalytic cracking and insulin) or a clockmaker working in metallurgy (continuous casting of metals). The latter is a curious historical echo of William Huntsman, the clockmaker of Sheffield, who discovered the crucible process for steel.

The main difference between 19th- and 20th-century inventors, as Jewkes points out, is that the apparatus of professional training was itself immature in the 19th century and that many professionals were "self-educated" in those days.

Turning from the inventor to his inventions, a sociologist would note that out of the fifty-three instances quoted only eight involved the establishment of a new industrial group as a viable entity. There was one bankruptcy and one suicide, the latter *after* the easy establishment of success and universal acclamation. Five inventions which started with private backing were duly absorbed into pre-established industries. Thirty-nine either found their way into pre-established industries or originated within them, and remained there. The inventive field is therefore dominated by the professional inventor, on the one hand, and pre-established industry, on the other. The social pattern is fairly clear.

The career pattern of inventors can be seen by dividing them into directors of, or employees in, industry, on the one hand, and independents on the other hand. The latter subdivide further into professors, consultants, and private persons. Thirty-two out of the fifty-three inventions came from directors of, or employees in, industry and twenty-one from independents of various shades. Seven of them

* "The Sources of Invention" by John Jewkes, David Sawers and Richard Stillerman (London, Macmillian, xii+428 pp., 31*s.* 6*d.*).

were professors, two were consultants and eleven were private persons including two amateurs and three borderline cases. Six out of eleven private persons were therefore of professional standing. Only ten out of the fifty-three changed their social environment as a result of developing their inventions. The commonest change was from the status of a private person to a director of, or employee in, industry. Whereas the economic pattern of invention is hard to discern, the social pattern is again fairly clear.

TECHNOLOGICAL STANDPOINT

A technologist interested in history would see the pattern somewhat differently. Compare, for instance, the achievements of Goodyear and Baekeland, on the one hand, with that of Carothers, on the other. Goodyear and Baekeland were, unknown to themselves, pioneering empirically in a branch of science which would one day come to be called "high polymer chemistry". Carothers worked in the same field just as the subject had shown the beginnings of its mature phase. Goodyear was concerned with cross linking rubber with sulphur; Baekeland with cross linking and polycondensation of phenol and formaldehyde; Carothers with polycondensation of dibasic acids and amines: nylon. Goodyear and Baekeland were pioneers, because they had to be empiricists. Carothers had a clear theoretical picture of what he was trying to do. The work of Goodyear and Baekeland was isolated from the main stream of the chemistry of their day. Carothers' work *was* the main stream of its time. Is it then remarkable that the Goodyear Rubber Co. and the Bakelite Corporation came into existence independently of the rest of the chemical industry whereas nylon was engendered by and absorbed into it?

A technologist again would discriminate between such topics as jet propulsion, and power from nuclear fission or nuclear fusion where there is an underlying theory of what has to be accomplished, and such topics as safety-razors and cotton-pickers where no such underlying theory exists. The former involve massive attacks on ancillary problems connected with materials, fabrication, safety, and controllability, and lend themselves to institutionalised development. The latter involve problems which are concrete rather than abstract and seem to be the natural fields for the ingenuity of the amateur who, having no knowledge of theory, is likely to do best where no theory is called for. He would also classify separately those inventions which, though latent in contemporary technology, were economically premature before a certain date. Some kind of household refrigerator, gearless transmission, power steering, diesel-electric locomotive or retractable undercarriage was within the competence of engineering science long before each was adopted into general use. Their invention demanded competence rather than genius and successful development turned upon production at a price likely to attract the buyer. In contrast to these are the ball-point pen, the zip-fastener, xerography, the cyclotron, the transistor, and the computer, the ingenuity responsible for each of which has power to astonish. Lastly he would discriminate between a discovery and its first useful application; it is the latter which is inventive. Perkin's silicones were discoveries. They had no foreseeable application for many years. It would be wrong to add this lapse of time to the further period required for development after their first use had been proposed, and to regard the sum of the two periods as a measure of development time.

THE ECONOMIC HISTORIAN

Returning to the economic standpoint, it is to be hoped that "Sources of Invention" is only the first of a series of publications from Prof. Jewkes' school. Ill-informed generalisations on this all-important subject can do a lot of harm and the only antidote to them is analysis based on facts. Compare, for instance, the British and the American pattern of inventive development. The U.S.A. has three times the population of Britain and the relative wealth of the two countries is as 10:1. What is marginally saleable and marginally profitable in Britain can under these circumstances be economically attractive in the U.S.A. In terms of these simple considerations invention should be a more rewarding profession in the U.S.A. than in Britain. After allowing for these and similar facts, does anything remain for explanation by way of contrast between their attitudes towards invention and inventors? In many fields the residue to be explained seems small. Traditional industries in each tend to have a higher-than-normal proportion of backward firms. The cotton trade is criticised in each. In each the building trade is regarded as restrictive and obscurantist.

Automobile designs and styling in Britain seem to lag about five years behind those of the U.S.A. The lag may reflect no more than the difference in relative purchasing power per head at any given date. One cannot, however, explain the British lag in blast-furnace design so easily. Technological history is fairly easy to disentangle; it is in the published literature or on file in the Patent Office. Economic history is hidden away in old board minutes and company correspondence; it is difficult to disentangle and where technology and economics intermingle their joint history is dubious accordingly. It is to the methods of the economic and social historian that we must look therefore if we would understand more deeply the factors that control the adoption of inventions and the length of the induction period that must elapse between invention and commercialisation. That the Oxford school have made a beginning on this neglected subject is indeed good news.

Editor's Note: The author wishes to point out that he has reanalysed the statistics of the book from a point of view quite different from that of the light in which Jewkes *et al.* themselves regard them, and comes to certain conclusions in altogether different dimensions. He states further that "in analysing statistics from case-histories it is impossible to do so in any very simple way because of the existence of borderline cases. A review, however, demands a simplified treatment, and therefore I have had to do my best with simple alternative classification. One could first of all insist that certain cases be withdrawn from consideration on the grounds that the classification does not apply. Secondly, one could dispute one or two of my allocations."

A CENTURY OF DIAZO COMPOUNDS

E. R. WARD, Ph.D., B.Sc., A.R.I.C. and J. L. RANDALL, B.Sc.

Leicester College of Technology

One morning in the year 1858, the porter of the Royal College of Chemistry in Oxford Street found himself confronted with a strange spectacle: a stocky foreign gentleman wearing a reddish-brown overcoat, sea-green trousers, a bright red muffler, and an enormous top-hat of a type seldom seen in Oxford Street. The porter was somewhat bewildered, and since he could not understand the gentleman's explanations, refused him admission. This brought forth a massive protest from the stocky German: "Ich heisse Griess und bleibe hier!" (My name is Griess, and here I stay!) Fortunately, this cry attracted the attention of Prof. A. W. Hofmann, who came hurrying from his laboratory to explain matters and to welcome his new assistant. In this dramatic manner the discoverer of the diazo compounds first arrived in London.

Johann Peter Griess was born on September 6, 1829, in Kirchhosbach, a small village set among the mountains of Central Prussia, not far from Cassel. His father, Johann Heinrich Griess, plied the trade of village blacksmith, and in addition owned a small farm which brought him quite a considerable income. His original plan was to educate Peter to carry on the management of the farm, but Peter had no interest in this and would often be found reading alone in a corner of a field when he ought to have been ploughing. Nevertheless, he was sent at the age of fifteen to an agricultural college, after which his career became extremely erratic. From the agricultural college he moved to Cassel Polytechnic, and thence at the age of twenty-one to Jena University, where he studied botany. A year later he moved again, this time to Marburg University, where he studied physics, philosophy, logic, and psychology. He was a riotous student, continually in trouble with the authorities, and in December 1853 he was sent down for a year. During this year he spent a few months with the great Liebig at Munich University, and in 1855 he was readmitted to Marburg, only to return to his former pranks. However, in his sixth year at Marburg he became sufficiently subdued to study seriously both physics and chemistry, and in 1856 he applied for a post at the tar distillery at Offenbach am Main, the same distillery where Hofmann had obtained his first specimens of coal-tar aniline.

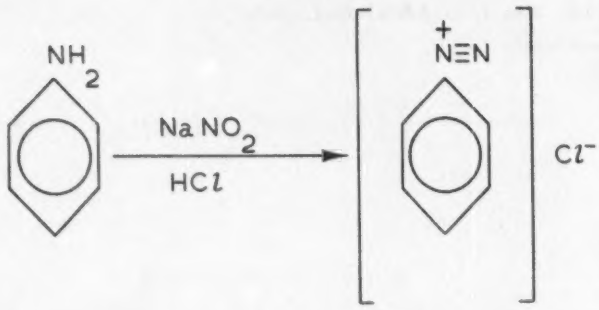
However, Griess did not stay long at Offenbach. Very soon a large portion of the works was destroyed by fire and Griess returned once more to Marburg to work under Prof. Kolbe. Now, however, he was a completely changed man, and became so devoted to his work that Kolbe was able to recommend him to Hofmann as an assistant. Hofmann, it should be explained, had been Professor at the Royal College of Chemistry in London since its foundation in 1845, and had principally occupied himself with the chemistry of coal-tar derivatives. At this time, Hofmann was not actually looking for an assistant and had no vacancy for one, but shortly afterwards he came upon a paper by Griess, which impressed him so much that he decided to invite Griess to London. This proved to be the great turning-point in Griess's life, and we have already related the strange and amusing manner in which he made his first impact upon Oxford Street.

FIG. 1. Peter Griess (1829–88), the discoverer of diazo compounds.

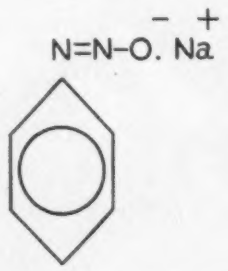
DISCOVERY OF DIAZO COMPOUNDS

The paper by Griess which had attracted Hofmann's attention was a note on the action of nitrous acid on certain aromatic amines, a piece of work which is now accepted as the discovery of the diazo compounds. (*Liebigs Annalen*, 1858, vol. 106, pp. 123–5.) It is true that before Griess other workers had treated aromatic amines with nitrous acid but the compounds they isolated were formed by further reaction of the intermediate diazo bodies and gave no clue to the existence of the latter (thus Perkin and Church in 1854, *before* the advent of Perkin's synthetic mauveine, unwittingly prepared an azo dye from α-naphthylamine). It was Griess's good fortune to choose experimental conditions and a starting substance (picramic acid) which gave an insoluble diazo compound. In most cases, diazo compounds are only stable at low temperatures and are not easy to isolate in the solid state. Thus, chemists usually prefer to work with them in solution, and it is possible to work with diazo compounds for years without ever encountering one in the pure, solid state. However, they are very readily prepared in solution by

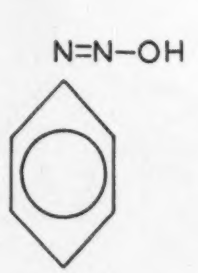
treating an acidified solution of an aromatic amine (such as aniline) with nitrous acid at low temperatures:



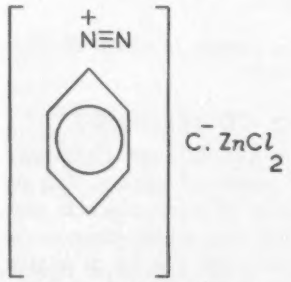
The form shown above is known as a "diazonium salt", in which the diazo part functions as a base but the diazo compounds have a complex Jekyll and Hyde character which also enables them to exist as salts with metals (when they themselves function as acids), in neutral forms, and as complexes with a great variety of both organic and inorganic compounds, for example:



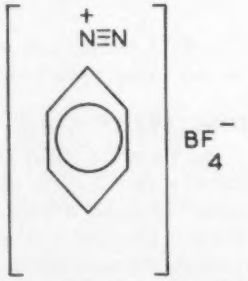
Sodium benzenediazotate



Benzene diazohydroxide



Zinc chloride complex of benzene diazonium chloride



Benzene diazonium borofluoride

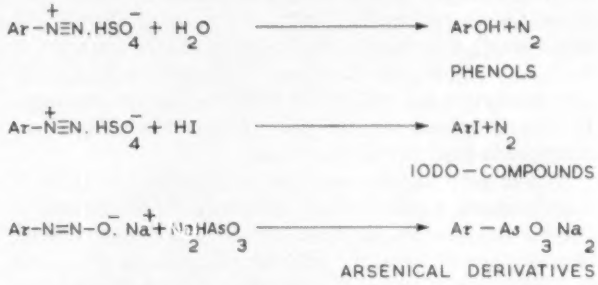
The solid diazonium salts are often extremely explosive, but by converting them to alternative stable forms they can be safely transported about for use in dyehouses or in photographic processes. Arrived at their destination chemical treatment liberates their reactivity.

It is the great reactivity of diazo compounds that makes them so useful as a tool in synthetic organic chemistry and Griess himself clearly stated this six years after his discovery:

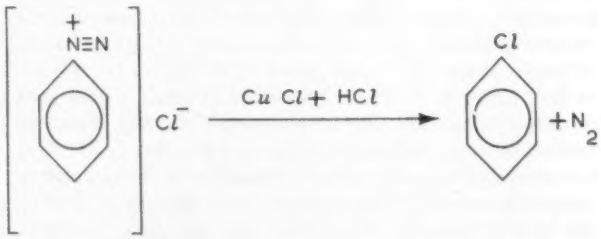
"They are remarkable for the great variety of compounds which they produce, such as is not met with in any other portion of the field of organic chemistry. When in the free state they are remarkable for their instability; their compounds, however, are somewhat more stable. . . . The very striking physical properties of these bodies, as well as the large number of products of decomposition to which they give rise, likewise deserve to be specially noticed. Altogether they may be looked upon as one of the most interesting groups of organic compounds." (*Phil. Trans. Roy. Soc.*, 1864, vol. 154, p. 667.)

REACTIONS

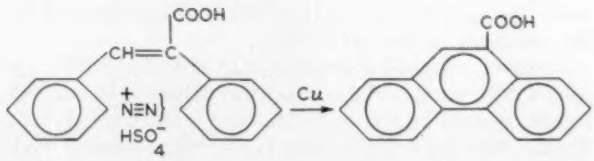
The diazonium salts undergo a range of reactions in which nitrogen gas is eliminated and the diazo group is replaced by other atoms or groups. These reactions are frequently used in syntheses and the following are typical:



For the introduction of bromine or chlorine atoms, the catalyst discovered by Sandmeyer in 1884, the corresponding cuprous halide, is employed.

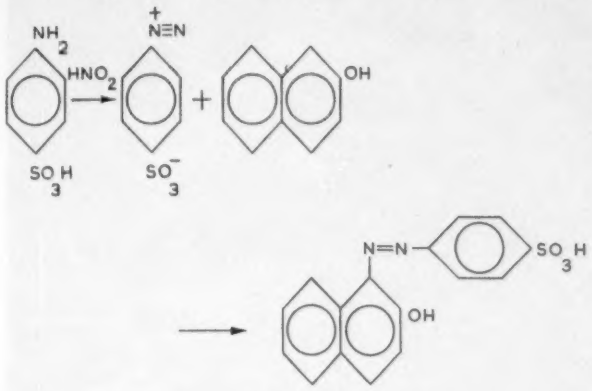


It is also possible to use diazo compounds to prepare complex aromatic systems; for example, the Pschorr reaction to synthesise phenanthrene derivatives.



However, there is no doubt that the most important reaction of diazo compounds is the coupling reaction which leads to the production of azo dyestuffs. These dyes all contain the azo link $-N=N-$ which is responsible for their colour (the "chromophore"), and groups such as $-NH_2$, $-SO_3H$, $-COOH$, which enable the dye to attach itself to the fabric. The azo link is formed by reacting a diazonium salt with a "coupling component" which may be a phenol, naphthol, amine, naphthol sulphonic acid,

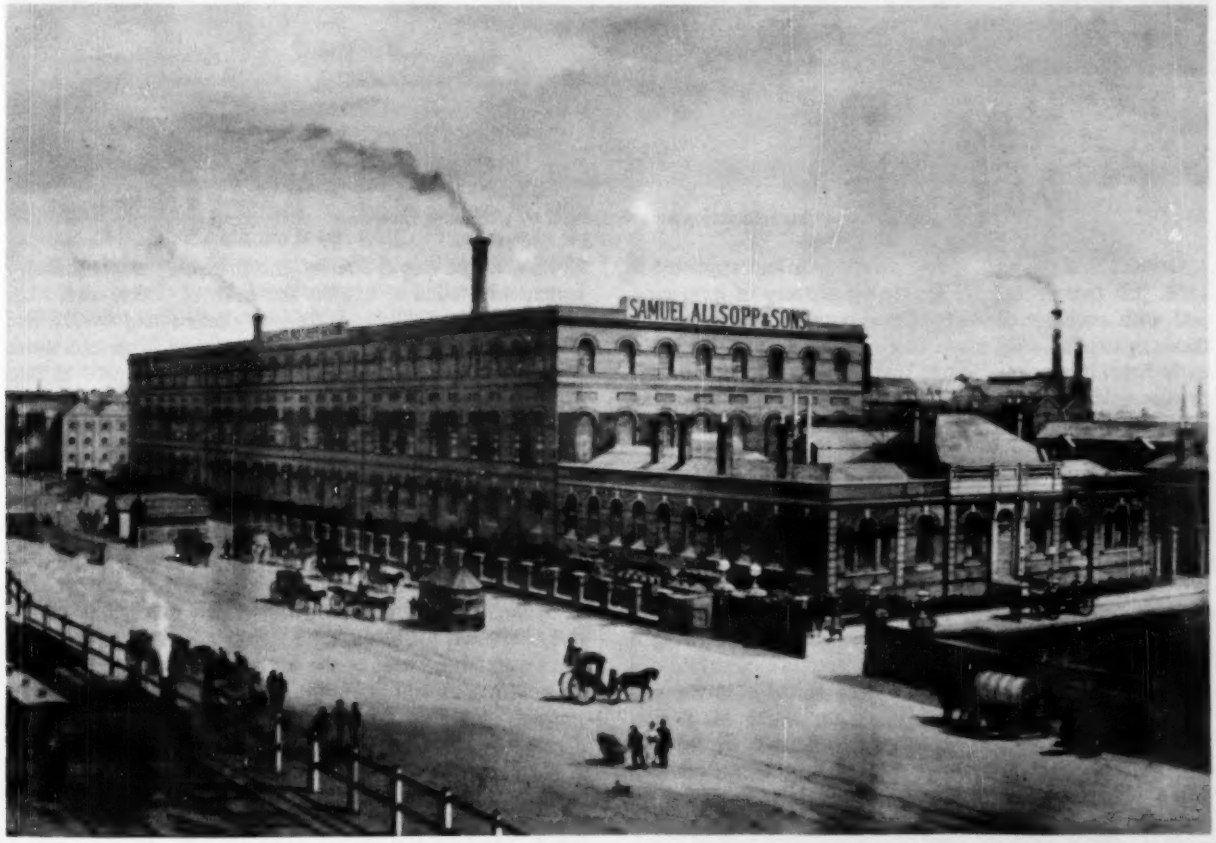
aminonaphthol sulphonic acid, and so forth; for example, the well-known Orange II is prepared as follows:



The number of possible combinations of diazonium salt and "coupling component" is literally infinite and new patents arise almost daily. The importance of azo dyes is clearly reflected in the fact that they constitute over half the production of synthetic dyes today and that the United States alone produces about 14,000 tons of azo dyes annually. Furthermore, no matter what method one chooses to classify dyestuffs, representative azo dyes will be found in each class. They can be used to dye every type of fibre, whether natural or synthetic. They also find widespread use as colouring matters for foodstuffs, rubber, plastics, and cosmetics (lipstick, for example).

GRIESS AND DYESTUFFS

To explore the growth of this vast azo dyestuff industry we must return to Peter Griess at the Royal College of Chemistry. Griess remained with Hofmann for four years, during which time he improved his English and assisted Hofmann in the study of such problems as the decay of stonework at the Houses of Parliament and the possible effect of vibration from underground railway trains on wine stored in the London docks. The College's intimate contact with the brewing industry led, in 1862, to Hofmann's recommending him as assistant to Dr Bottinger at Allsopp's Brewery in Burton-on-Trent. He succeeded Bottinger as chief chemist in 1866 and remained until his sudden death in 1888. While Griess made many valuable contributions to the brewing industry, especially in developing analytical techniques, his principal interest was still with his beloved diazo compounds and all his spare time was devoted to their study (the company affording him facilities for this). Like Perkin, that other great dyestuff chemist, not a little of this interest was of an aesthetic character. We find him writing, for example, that a certain green substance is "one of the finest bodies of which chemistry can boast", and of another series of derivatives that "they are likewise remarkable for their great beauty, a property which certainly encourages closer acquaintance".



(Courtesy of Ind Coope and Allsopp Ltd.)

FIG. 2. Allsopp's Brewery as it was in 1860.

(*Courtesy of Dyestuffs Division, ICI*)

FIG. 3. Manufacturing an azo dyestuff by a coupling reaction.

Griess's first paper on diazo compounds had appeared in 1858, just two years after Perkin's discovery of mauveine, and with such tremendous contemporary interest in synthetic dyestuffs (many made vast fortunes from them in the early days) it is not surprising that Griess's attention turned to this field. Griess's researches on azo dyestuffs were of a most profound character, but remarkably enough it was others who successfully exploited his work commercially. Griess himself took out patents for dyes but these made him no money. Griess's greatest contribution, of course, was the discovery of the coupling reaction, to which we have referred already, and by which the great majority of azo dyes are produced. He was the first to produce azophenols, *bis*-azo phenols and, in 1884, he patented dyes which would dye cotton without mordants, this being a great step forward in the industry. Griess's contributions to dyestuffs chemistry were far more valuable in the end than those of Perkin. The speed with which his fundamental discoveries were exploited can be seen by the fact that by 1884 German patent specifications alone covered about 9000 *different* azo dyes, although only a few of these were commercially valuable. It was unfortunate that Griess's work was not fully appreciated in this country, and although he was recognised in academic circles by election to the Royal Society, the British dyestuffs industry lamentably failed to exploit the work of Griess and other pioneers. The industry went into decline and by the end of the 19th century Britain was exporting large quantities of coal tar to Germany for the Germans to process into dyes. It is strange that Griess did not abandon the brewing industry and enter the dyestuffs trade where he could have devoted all his time to dyestuffs research, where his real interests lay. His domestic commitments in Burton prevented this, but it is to be regretted.

EXPLOSIVE PROPERTIES

The uses of diazo compounds are by no means confined to dyeing. Griess, in his earliest paper, notes their explosive character, for he says: "This substance [a diazo-oxide] cannot stand the heat of the water bath but is decomposed by it with a violent explosion." In a later paper (1864) he suggests that "the explosive properties of the nitrate of diazobenzol may, perhaps, at a future period find practical application". An anonymous writer to the *Yorkshire Post* (April 19, 1916), who claims to have known Griess personally, describes two great explosions, one of which occurred during a lecture by Griess at Heidelberg. Griess had been invited to lecture there by Bunsen, and undertook

to demonstrate the explosive properties of his "diazobenzol nitrate". Bunsen, who was acting as his assistant, added too much of the nitrate, with the result that both Griess and Bunsen were blown off their feet, a window was blown out, and a hole made in the ceiling! Later, these properties of benzenediazonium nitrate were put to use in detonators, in place of mercury fulminate. The diazo compound most frequently used in this way is the diazo-oxide obtained by diazotising picramic acid, which is in fact the original compound discovered by Griess.

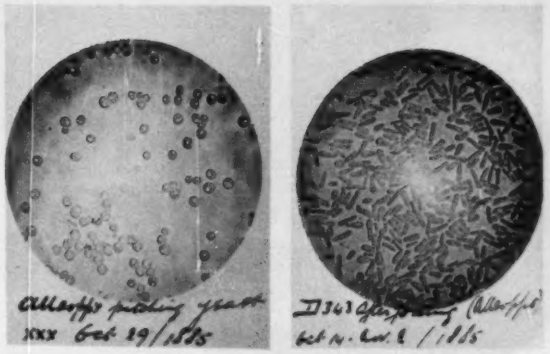
DOCUMENT REPRODUCTION

Another application of diazo compounds lies in colour photography and in the production of diazotypes. If light is allowed to fall on an emulsion containing a suitable diazo compound, the diazo group (−N=N−) is removed by photo-decomposition. Thus if the emulsion is used in a photographic camera, those parts which receive no light will remain unchanged, while the parts which are exposed will lose their diazo compound. The picture may then be "developed" by placing the emulsion in a bath of some coupling reagent which forms an azo dye with the unchanged diazo compound. Emulsions prepared in this way are not very sensitive, and their main use is for copying material of high contrast, such as line drawings or typewritten matter. These reproductions are known as diazotypes, and are used on a vast scale in industry and commercial practice for the rapid reproduction of plans and documents. It is interesting to note that this process was first applied to the printing of cotton cloth by Green, Cross, and Bevan in 1890. The cloth was first dyed with Primuline, a dyestuff which is capable of diazotisation, and then treated with nitrous acid. This produced a diazonium salt in the fibres, and after exposure to light under stencils the cloth was run through a developing solution of β-naphthol. In a similar way, cellulose acetate cloth can be printed after impregnation with a suitable arylamine. However, this method of printing cloth never seriously competed with the usual techniques, and the main application of the diazotype process today is in document reproduction.

There are two ways in which diazo compounds are used for copying; either the paper is impregnated with the diazo compound alone and later developed in a bath of coupling reagent, followed by rapid drying, or else both components are already present in the paper. In the latter case, some way has to be found of preventing coupling before the paper has been exposed. This can be done in several ways, but one of the most useful is by control of acidity. The two components present in the paper will not couple until the paper is made sufficiently alkaline, and this is brought about when required by exposure to ammonia fumes. A great variety of machines for using either process and capable of operation by relatively unskilled labour are now available as illustrated here.

CHEMOTHERAPY

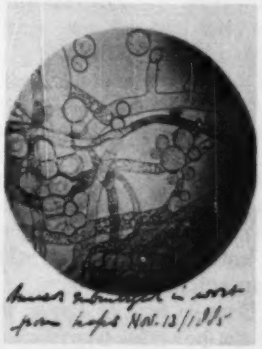
This account of the diazo compounds would not be complete without a reference to another branch of chemistry and medicine which is derived indirectly from them, namely, chemotherapy. The synthetic drug industry is in many ways an offshoot of the synthetic dyestuff industry, since most of the early man-made drugs were dyes. This



(*a*) Samples of Allsopp's pitching yeast (1885). Descendants of this yeast are being used in the brewery today.

(*b*) A pure yeast culture.

(*c*) Sediment from draught beer after one month's incubation.

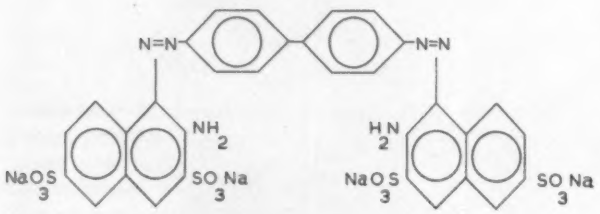


(*d*) Sample of mould contaminant of hops.

FIG. 4. Photomicrographs taken by Peter Griess. (The writing on the photomicrographs is that of Mr Dryden who was Head Chemist between 1908 and 1949.)

FIG. 5. The "Hermes" plan copying machine. The top is raised to show the light source of twelve fluorescent tubes. (*Courtesy of E. N. Mason and Sons Ltd, Colchester.*)

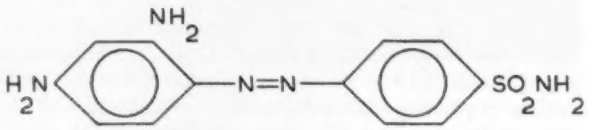
development began with Paul Ehrlich, who made a number of observations on the staining of animal tissues with dyes. Ehrlich noticed that many dyes attached themselves to specific parts of the tissues, and conceived the idea of a dye which would destroy invading bacteria without affecting the host. His first success was with a dye which would cure trypanosomiasis in mice; this he named "Trypan Red":



Trypan Red

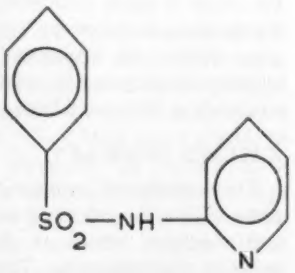
It was discovered in 1903 and was rapidly followed by other trypanocidal dyes such as Trypan Blue and Afridol Violet. Ehrlich's work eventually led him to the discovery of the famous anti-syphilitic drug "salvarsan", modifications of which are still in use today.

In 1920 the German firm of Bayer, following Ehrlich's lead, produced the powerful trypanocidal drug Germanin which is used against sleeping sickness. This is not a dye, but is a development from the early researches on dyes. In 1932 I. G. Farbenindustrie patented the azo dye Prontosil, and G. Domagk in 1934 found it to be remarkably effective against streptococcal and staphylococcal infections. Later it was shown by French workers that



Prontosil was split in the body to sulphanilamide and that this was the active metabolite. Thus Prontosil was the first of the sulphanilamide drugs and quickly led to the development of a host of substances related to the active metabolite, one of the most important being the renowned sulphapyridine (M and B 693).

Sulphanilamide
(*p*-aminobenzenesulphonamide)



Sulphapyridine

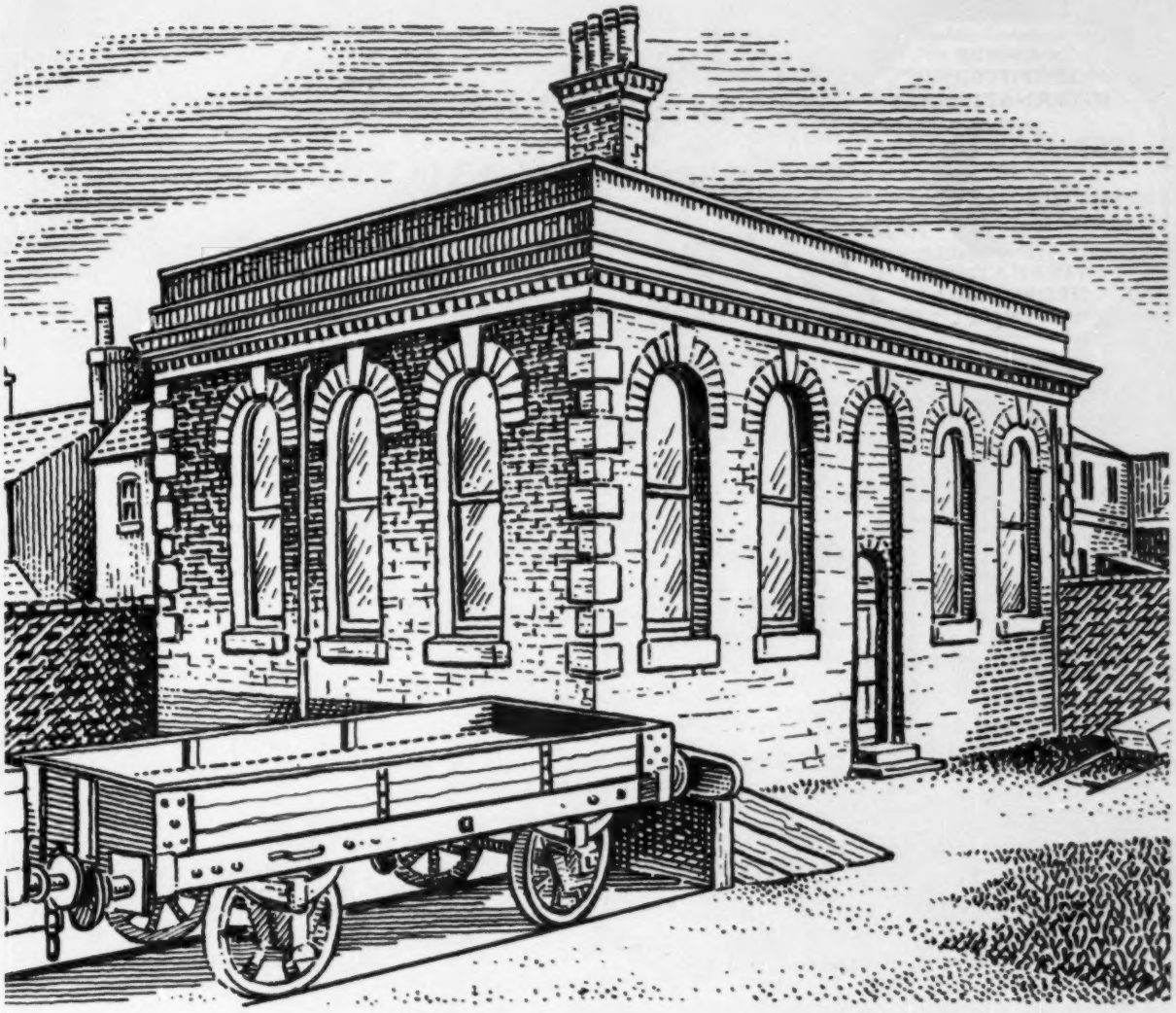
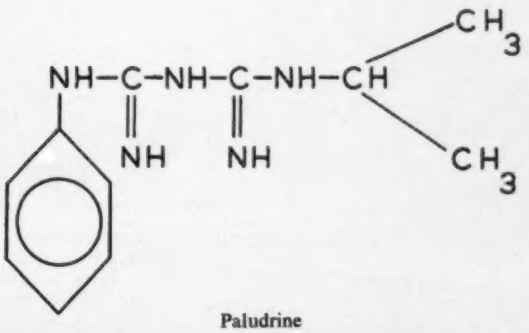


FIG. 6. Sketch of Griess's old laboratory, copied from *The Red Hand*, vol. 6. No. 4, p. 5.

Finally should be mentioned the most effective anti-malarial drug Paludrine, discovered during the last war by ICI workers, and whose synthesis involves the use of diazo compounds.



Paludrine

THE SIGNIFICANCE OF GRIESS

Thus we see that from Griess's original discovery has sprung a vast and ever-ramifying branch of chemistry which has had the most profound social and economic consequences. It is interesting to note that most of the great discoveries in diazo chemistry have been made by British and German chemists.

In celebrating this year the centenary of the birth of diazo compounds, chemists throughout the world will be paying tribute to the great genius of Griess himself. Griess, the riotous youth who came eventually to marry the daughter of a Burton-on-Trent medical practitioner and settled into a quiet domestic routine in this small Staffordshire town. And if chemists should want to toast his name, what better medium could they choose than Allsopp's Ale itself, still brewed with the same strain of yeast employed in Griess's time!

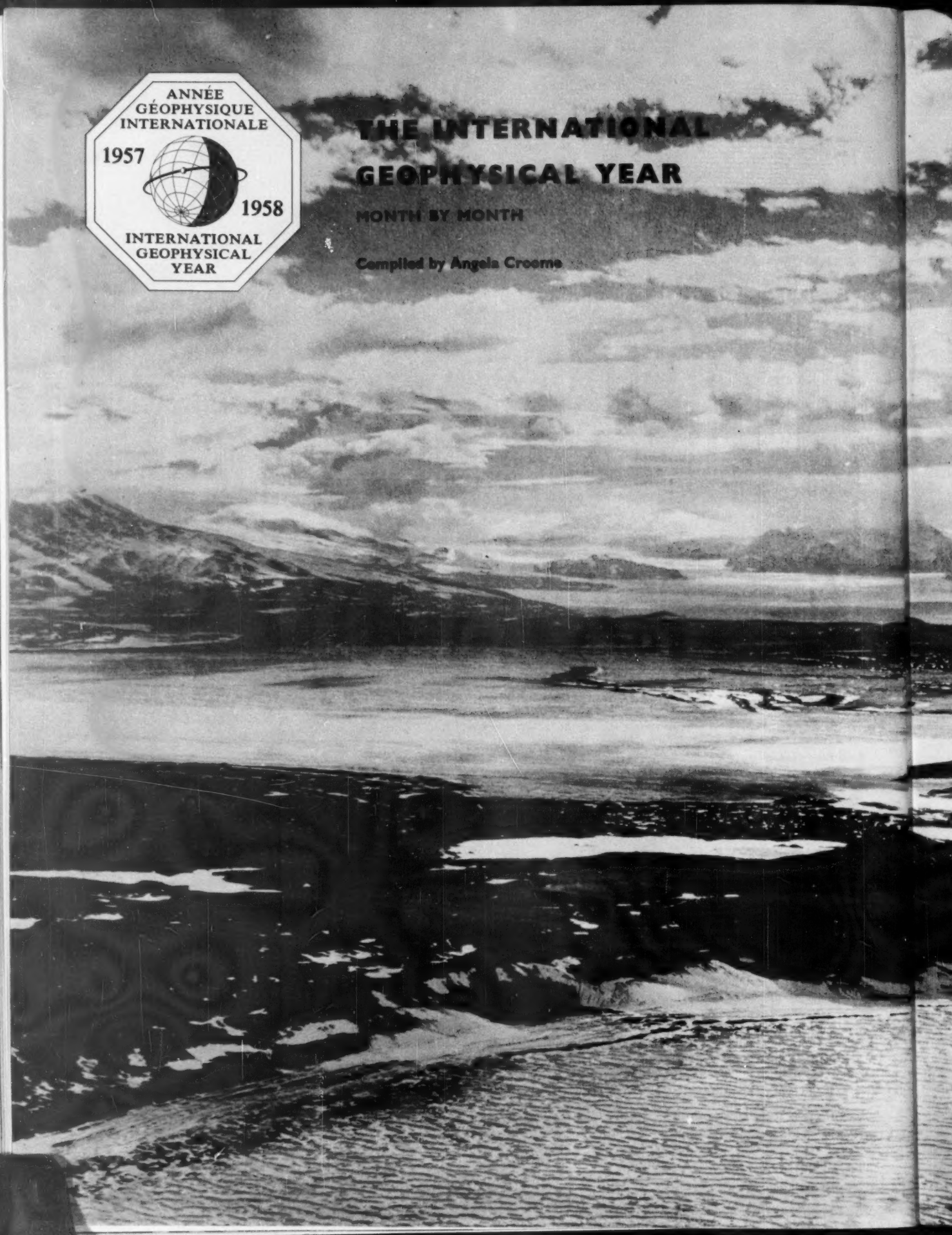
BIBLIOGRAPHY

"The Aromatic Diazo Compounds", K. H. Saunders, Arnold, 1949.

"Memoirs on Peter Griess", *Ber. dtsch. chem. Ges.*, 1894, vol. 24R, pp. 1007–72.

"J. P. Griess", F. A. Mason, *J. Soc. Dy. Col.*, 1930, pp. 33–9.

"A Hundred Years of Synthetic Dyestuffs", E. R. Ward, DISCOVERY, 1956, vol. 17, p. 189.



THE INTERNATIONAL GEOPHYSICAL YEAR

MONTH BY MONTH

Compiled by Angela Croome

We have pleasure in extending congratulations to Sir Vivian Fuchs and the Commonwealth Trans-Antarctic Expedition on the timely and successful completion of "the last great journey". Next month should see them home and we look forward to hearing more of the research that was accomplished in such arduous circumstances.

TIMETABLE OF TRANS-ANTARCTIC EXPEDITION
1957–8

Oct. 8, 1957 Depart Shackleton for South Ice on reconnaissance of vehicle route on to Polar Plateau.

Nov. 13 Arrive South Ice on reconnaissance trip. Return immediately by air to Shackleton for the crossing proper.

Nov. 24	SHACKLETON BASE, crossing starts				
		350			
Dec. 22	Arrive SOUTH ICE				
Dec. 25	Depart			930 miles	
		580			
Jan. 20, 1958	Arrive POLE				
Jan. 24	Depart				
		500			2100 miles (approx.) in 99 days
Feb. 6	Arrive Depot 700; meet Hillary				
Feb. 10	Depart	80			
Feb. 13	Midway Depot				
		140			
Feb. 18	Depot 480			1200 miles	
		200			
Feb. 24	Plateau Depot				
		100			
Feb. 27	Skelton Depot				
		180			
March 2, 1958	SCOTT BASE, crossing ends				

Mileages have all been announced in round figures, so that the runs between depots do not always add up to the official totals.

Sputnik II up till Mid-April?

On February 16 *Sputnik II* completed 1500 revolutions of the Earth—and its 105th day of existence. At the beginning of March, forecasts given by the Royal Aircraft Establishment, Farnborough, which has been conducting visual observations from several points suggested that the object would remain in orbit for a further six weeks, that is, until about April 15. By mid-February Soviet observations showed a decrease in the satellite's period of 6·2 minutes; this give an orbiting time of 97·5 minutes at that date as against 103·7 at launching at the beginning of November. The daily decrease in period at this time (mid-February) was 4·7 seconds as against 2 seconds at the beginning of its career. Up till December 31 the period had decreased by only 2¼ minutes, according to calculations made by Farnborough.

Soviet scientists also reported in mid-February that apogee had come in by 366 miles, to about 670 miles.

In January the Soviet Academy of Sciences forwarded the "Preliminary Report on Launching in the U.S.S.R. of the First and Second Artificial Earth Satellites" to IGY headquarters in Brussels. It added little to what was already known and indeed specified that the greater part of the material had already been published in different ways. Analyses of data gathered by the satellites was still going on, it explains, so that it contains no statistical information at all on conditions at orbital heights.

The report, however, does clear up one or two points that had remained obscure. For instance, it had generally been taken that the air-temperature measurements made by *Sputnik I* were of the ambient air. It is now clear that temperature measurements associated with both *Sputniks* (*Sputnik II* carried temperature gauges for three distinct measurements) were all of *inside* parameters. Nevertheless this arrangement enables the Russians to state categorically that the satellite suffered no damage from collisions with meteors during the twenty-three days that its radio continued

FIG. 1. The Skelton Glacier photographed from the air by a *Times* photographer.

transmissions (two major meteor showers occurred during this period). The satellite shell was made airtight before launching and filled with gaseous nitrogen, so that a puncture enabling the gas to escape would have been immediately reflected by a change in the internal temperature readings.

New Zealand Sledgers Beat Amundsen Run

The two-man New Zealand surveying team that set off from Scott Base last October to investigate territory along and behind the mountain ranges to the west of the Ross Sea, returned to the base on February 19. They had covered 1700 miles on foot behind their two husky teams, and have thereby beaten the celebrated run by Amundsen to the Pole and back by dog sledge.

More Refined Experiments for *Sputnik III*

Two pieces of apparatus for the more refined study of charged particles above the atmosphere have been prepared and tested for inclusion in future *Sputniks*. These are an ionisation chamber and a counter for detecting Cerenkov radiation from cosmic rays. This apparatus enables the particles to be sorted by energies and also by mass (which can be translated into the distribution of elements in the total primary radiation and thereby throws light on the origin of cosmic rays). The two Geiger counters in *Sputnik I* could only measure the variation in overall intensity of the radiation as the satellite moved round the Earth. Not surprisingly this showed that the intensity varied with geomagnetic latitude—a fact that has been known from studies at the Earth's surface for a number of years. Dr Lydia Kurnosova has supervised the work on the instruments.

Another woman scientist, Dr Ada Kotovskaya, has been training another dog (called Alpha) for a satellite flight. She was Laika's trainer.

***Explorer* and a Solar Flare**

A major magnetic storm associated with a large solar flare took place in mid-February, about ten days after *Explorer*'s launching. By an unfortunate irony the flare (the kind of event from which American scientists had hoped to learn so much), was responsible for a partial black-out of the satellite's signals. It so happened that the more powerful of the satellite's two transmitters had ceased operating a short time before. It had been thought that the frequency (108 Mc/s) was too high to be much affected by disturbances in the ionosphere, but this seems not to have been true of a really bad storm such as occurred on this occasion. Just when the maximum information was required the continuous record of signals was interrupted.

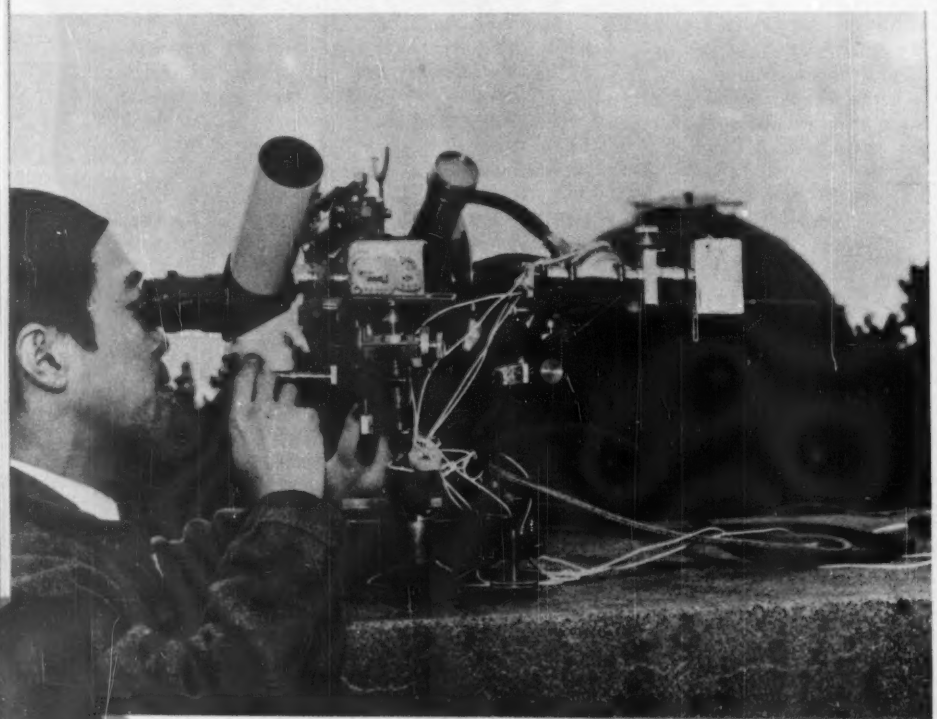
The storm or series of storms caused world-wide disruption of radio communications and particularly magnificent auroral displays, some of them at quite low latitudes. The flare was not visible from Britain (though the *aurora* was) and the magnetic storm conditions that followed it seem to have been considerably more severe on the other side of the Earth. Australian radio engineers described it as the biggest since 1950 and American reports spoke of the largest this century or even since 1500. Satellite tracking-stations at Woomera and Canberra received *Explorer*'s signals patchily for two days, but other Australian stations heard nothing for twenty-four hours. At the time of going to press it was still not known how American tracking fared but as the instruments in *Explorer* transmit their readings continuously the information from every "first line" station (and these include those in Australia, Japan, and at Singapore), is needed in full to make the telemetry record on each circuit complete.

Major disturbances on the Sun also affect cosmic rays, and it was hoped that a flare might take place before the satellite's batteries gave out, so that, for the first time in history, the effect of solar eruptions on cosmic rays above the atmospheric cut-off could be compared with the cosmic-ray pattern at sea-level where observations are carried on continuously. Latitude is an important factor in the interpretation of cosmic-ray data. This makes the completeness of the telemetry record important. Then intensity variations can be plotted both against the satellite's exact position above the Earth and against its height and so have meaning.

It may be some time yet before we know how serious was the overall effect of the mid-February flare on reception of *Explorer*'s signals. No doubt a great deal can be pieced together from the tape records made round the world of what appears to have been a remarkable if not an unprecedented solar event. The physics department of the State University of Iowa (which designed the cosmic-ray experiment) is carrying out this analysis.

Future *Explorers* will carry a ¼-lb. tape-recorder to store the information collected on each circuit of the Earth, for play-back at command. This should avoid telemetry losses between tracking stations. The abortive *Explorer II*, launched on March 5, carried such an instrument.

FIG 2. A photoelectric theodolite for tracking the Russian and American Earth satellites has been developed by the Tokyo Astronomical Observatory. The new theodolite is a combination of the conventional telescope, photoelectric amplifier, and small camera. It is claimed to be superior to the Schmidt camera, at one-fiftieth the cost.



Rocket News

Information has recently come to hand of the design and performance of the Soviet Union's "meteorological rocket" which is being widely used in the IGY programme. At least fifty-five of these rockets are scheduled; twenty-five are being fired from Kheis Island off Franz Josef Land in the Arctic and thirty are going off from the *Ob* on her current Antarctic voyage. Probably some of the forty rockets to be fired from Russia's other rocket-firing zone along the 60th parallel, in Central Russia, will be of this type, too. In response to a recommendation made at the Washington rocket conference in the autumn of 1957 for a concentration of rocket flights during June and July 1958,

the Russians have reorganised their programme to increase firings at this time.

The meteorological rocket is partly recoverable and has a range up to 60 miles. It is made up of three parts: the instrument-carrying head, the body containing the rocket motor, and a compartment located in the bottom of the head containing a mortar for separating the two. The overall length of the rocket is 23 ft., 6½ ft. of which is accounted for by the head. The body weighs 485 lb. and carries a stabilising unit as well as the liquid-fuel motor and tanks. The rocket is launched from a 40-ft. tower up which it travels along four spiral grooves that act like rifling. The rocket is boosted to a speed of 660 ft. per sec. while the stabiliser gradually checks the spinning motion. The rocket motor, on its own, further accelerates the vehicle to about 3600 ft. per sec. at a height of 18 miles and then cuts out.

From here the rocket coasts to about 45 miles high, where the separating-mechanism fires; at the same time two parachutes open, one attached to the nose and one to the rocket body. The nose section continues upwards for another 10 miles or so, the parachute acting as a stabiliser preventing tumbling. Subsequently the parachute slows down the nose on its descent, enabling it to touch down at about 13 to 16 ft. per sec. Bayonet-like blades dig into the ground and hold the container with the precious load of instruments upright and clear of impact. The rocket body also descends to the ground on its parachute, and after the motor has been cleaned this section can likewise be used again.

At the end of 1957 the first rocket experiments to be carried out in the Antarctic were conducted by a team from the State University of Iowa from "rockoons" launched from the *Glacier*. Some twenty-six firings were made with heights attained ranging up to 80 miles. Cosmic rays and the *aurora* were the main concern of the investigation.

Seismic Results from Tashkent Blast

A kiloton explosion of dynamite in a desert of Central Russia has had the double result of producing a reservoir in the area for water storage and providing IGY scientists at forty seismic stations with valuable data on the local structure of the Earth's crust.

The explosion which took place near Tashkent in Uzbekistan at the end of last year blew a cavity 140 ft. deep and 600 ft. in diameter and scattered the hundreds of thousands of cubic yards of earth that rose from it over an area over half a mile across. Seismologists from the Mathematics and Mechanics Institute of the Uzbek Academy of Sciences have been able to determine the crustal structure down to a depth of 30 miles by studying the mode of travel of the waves emanating from the crater. In contrast to the information derived from natural earthquakes, both the precise time and the precise force of the explosion were known, so making interpretation much easier.

It appears from the now complete analysis of records that the constitution of the rock down to 30 miles beneath Tashkent is made up of three distinct layers. The loess and other soils which form the surface extend down for 3 miles; below that lies a region of granite 19 miles thick, and below that, a 9-mile-thick layer of basalt.

The explosion was an experiment for the mining and construction engineers as much as for the seismologists—and a successful one. A plan to clear a 5-mile-long channel in the bed of the Angara river with a 30-kiloton explosion will now go forward. A substantial earth tremor from this is expected to be felt for a distance of a mile all round.

This spring the Canadians are to make a similar double-purpose explosion by blowing the top off Ripple Rock which is a nuisance to shipping off Vancouver. The American explosion of an atom bomb inside a Nevada mountain last year proved disappointing seismically.

FIG. 3. Silver Pears Trophy for Prof. Sydney Chapman. In recognition of the part he has played to make the IGY truly international and the most successful venture in peacetime scientific progress, Prof. Sydney Chapman has been awarded the 1957 Silver Pears Trophy. Prof. Chapman is the President of the organising committee for the IGY, and with the distinguished U.S. scientist, Lloyd Berkner, was instrumental in developing the idea as far back as 1950.

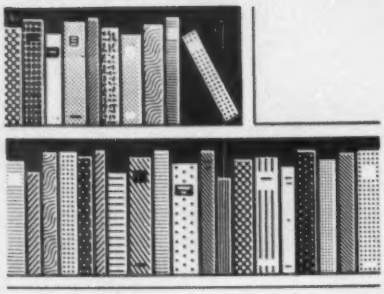
Antarctic Symposium in New Zealand

In accordance with a proposal favourably received at last summer's Antarctic IGY conference in Paris an informal symposium on the Antarctic was held in Wellington from February 17 to 22. Seventy scientists from seven nations now taking part in the Antarctic IGY programme attended; these countries were (beside New Zealand) Argentina, Australia, Britain, France, the United States, and the U.S.S.R. The largest delegations came from the last two countries mentioned; delegates were particularly impressed by the Russian work in oceanography, it is reported. Dr G. de O. Robin, the Australian scientist recently appointed to the directorship of the Scott Polar Research Institute, was the British representative. Dr Fred Jacka, chief physicist of the Antarctic division of the Australian External Affairs Department, attended for Australia and Dr Bertram Imbert, the retiring leader of France's 1956–7 expedition for France.

At the opening ceremony, the New Zealand Prime Minister, Mr Nash, reiterated his hope of reserving Antarctica for peaceful and scientific purposes and the possibility of placing it under United Nations trusteeship. He said, "I would like to see Antarctica administered by some [international] body so that it would be to the advantage of all nations. The United Nations is the logical choice but an independent organisation could be established. . . ."

It is hoped that an account of the scientific content of the symposium will be given in a later issue of this journal.

THE BOOKSHELF



Antiquity, No. 124

Vol. 31, 185–256 pp. Evolution Number, December 1957 (*London, Phoenix House, 10s. 6d.*)

An edition limited to 1000 copies of this special Evolution Number, celebrating the centenary of the presentation of Charles Darwin's paper on the Origin of Species to the Linnean Society in 1858, is published as a cloth-bound volume. This number represents the last work of the regretted founder and editor, Dr O. G. S. Crawford, who died recently while it was in the press.

Archaeologists everywhere will be relieved to know that the future of this valuable magazine is now secure in the hands of an Editorial Board of distinguished colleagues. For thirty years and more *Antiquity* has been an influential part of the British archaeological scene, not only the mouthpiece of its energetic, contentious, and respected editor, but a vehicle for the publication of much original work in all periods of archaeology and from all over the world.

The number under review includes an introduction to the contents in the form of characteristically brief and trenchant editorial notes. Main contributions are by Dr R. Singer (University of Cape Town) on the physical evolution of Man, by Dr K. P. Oakley (British Museum (Natural History)) on the evolution of tools, by the late (and greatly lamented) Prof. V. Gordon Childe (University of London) on the evolution of society, and by Prof. Leslie A. White (University of Michigan, Ann Arbor) on the evolution-versus-diffusion controversy.

The next long article, in factual rather than philosophic vein, is by Mr R. J. C. Atkinson (University of Edinburgh) on worms and weathering; it contains the collected observations of a skilled excavator on these influences, so important to "dirt-archaeologists", but so generally neglected in their cogitations. This is peculiarly apposite in the present context, as a reminder of Darwin's own fundamental study of earthworm activity.

Sir Mortimer Wheeler writes a reminiscent and appreciative review of J. R. C. Hamilton's official publication on the excavations at Jarlshof, Shetland, entitled "Civil-Service Archaeology", enlisting *Antiquity* as a fellow-critic of past shortcomings of the hard-working and understaffed Ancient Monuments Department of the Ministry of Works.

The final article records the latest progress in the fascinating decipherment of Minoan Linear "A" script, by Cyrus H. Gordon (Brandeis University, Waltham, Mass.), of which the language proves to be not only Semitic, as already forecast by this author, but East Semitic (Akkadian). To criticise the details of this will be beyond the competence of any but Semitic language philologists. Book reviews from contributors at home and overseas complete the number.

The literature of archaeology, like that of any speciality nowadays, tends to consist largely of records of minute and painstaking observations of human phenomena, as revealed by the material works of man, in some strictly limited region and period. It is good, once in a while, to see some leading researchers stand back to view the wood as a whole in their particular spheres, uninhibited by the too close proximity of the trees. The result here is a series of documented summaries, which will well constitute a brief introduction to the wider study of man and even, for the student and non-specialist, a gold-mine of references for further reading, if the initial interest aroused impels the reader to go more deeply into the subjects treated. It well illustrates the necessary co-operation of disciplines from both Arts and Science Faculties to make the best and fullest possible picture of early man, from the half-ape stage up to urban and commercial societies, which is the true aim of all concerned with Antiquity.

I. W. CORNWALL

The Truth About Cancer

By Charles S. Cameron, M.D. (*London, Hutchinson Medical Publications, 1957, 256 pp., 30s.*)

Any reader who anticipates that *The Truth About Cancer* will reveal some hitherto undiscovered fact or theory about cancer is in for a disappointment, for Dr Cameron's message is that diagnosis at an earlier stage would double the proportion of lives of cancer patients which are at present saved by surgery and radiotherapy.

He describes at length Cancer's Seven Danger Signals (sores that refuse to heal, lumps in the breast or elsewhere, unusual bleeding, prolonged indigestion, hoarseness or cough, a change in usual bowel-habits). But might not repeated weekly examination even of a single site only, such as one's mouth, induce cancer-phobia, and if many people went to their doctor whenever they suspected cancer, would not the consulting-rooms soon be overflowing? Of course early diagnosis and treatment should be aimed at, but is not the author a shade too optimistic in estimating that early treatment would double the chances of survival? and survival for how long? The book also contains chapters on the distribution, causes, misconceptions, treatment, and quackery of cancer and on cancer of the different sites of the body.

The layman will not care for the repulsive colour-photos of different forms of human cancer; but perhaps he will be cheered up by the illustrations of giant x-ray tubes. At the present time the growing tip of cancer research is believed by some experts to be in the fields of the demography and statistics of cancer, and in an indirect way, so does Dr Cameron. He states that (1) cancer of the bladder in Egypt is caused by Bilharzia infection, (2) arsenic-containing water facilitates skin cancer, (3) an iodine-poor diet promotes goitre, (4) a vitamin B-deficient diet induces a pre-cancerous condition of the mouth, pharynx, throat, and oesophagus, (5) a protein-poor diet leads to liver cancer, (6) some food additives are carcinogenic, (7) betel-nut chewing causes cancer of the mouth, (8) head-shaving leads to scalp cancer, (9) over-exposure to sunlight results in skin cancer, (10) circumcision prevents penis cancer and is somehow involved in a low cervix-cancer rate, (11) cigarette-smoking and urban atmospheric pollution are very important factors in lung cancer, (12) Jewish women are one-fifth to one-tenth as liable to cervix-cancer as are non-Jewish women, (13) stomach cancer in men is twice as common in Denmark as in New York.

Cameron concludes that:

". . . there is no reason to believe that people in one part of the world are any less susceptible to cancer in general than people anywhere else, nor to assume that we today are more prone to cancer than our great-grandparents were. . . ." He italicises the whole of this paragraph except for the key-word "susceptible", which can only mean that the forms of cancer just catalogued have an *environmental* basis; that is, something could be done about them by preventive hygienic measures.

On the subject of cigarette-smoking, atmospheric pollution, and lung cancer, Cameron takes up a timid position which is supposed to represent genuine scientific caution but could be interpreted as merely avoiding trouble.

I. HIEGER

CHAPMAN & HALL

* *New Books* *

GENERAL ZOOLOGY

by

Mary J. Guthrie (Professor of Biology, Wayne State University) **and** **John M. Anderson** (Associate Professor of Zoology Cornell University)

A JOHN WILEY BOOK

Size: 9¼" × 6¼" *723 pages.* *Illustrated.* *60s. net.*

This book is based on the well-known *Textbook of General Zoology* by Professors Guthrie and Curtis and is published in preference to a fifth edition of that work. Throughout, the authors have aimed at providing a proper balance between facts and interpretation—combining in proper proportion a sufficient amount of factual information with a useful measure of the interpretations and conclusions which give meaning to the facts.

POLYURETHANES

by

Bernard A. Dombrow

(Director of Laboratories, Plastics Division, Nopco Chemical Co., N. Arlington, N.J.)

A REINHOLD BOOK

Size: 7¼" × 5¼" *176 pages.* *Illustrated.* *36s. net.*

A further volume in the Reinhold Plastics Applications Series, in which the uses and possibilities of the polyurethanes are thoroughly discussed. Full particulars of their many applications as foams, and as coatings, rubber (castings as well as tyres), and adhesives, are included.

37 ESSEX STREET, LONDON, W.C.2

On the Dynamics of Exploited Fish Populations

by R. J. H. BEVERTON and S. J. HOLT

Science is prediction, and even on the high seas, fished by numerous nations, there can be prediction of one effect or another of man's pressure on the fish population. In this unique handbook, written by two brilliant zoologists, a solution can be found to any problem of fishery regulation in the world, provided the right data are available; or, if not, this work shows precisely what data are needed. Many of these methods will be applicable to other living populations and this book is unlikely to be equalled for many decades. Illustrated; bibliography and index.

£6 6s. (*post* 2s.)

HMSO

from the Government Bookshops or through any bookseller

The Strategy of the Genes

PROFESSOR C. H. WADDINGTON

Professor Waddington expounds some of the recent modern genetical theories of evolution and suggests that they have, up to the present, been applied in too narrow a way. He shows how a synthesis of population genetics and developmental ideas provides a more penetrating insight into the problems of adaptation, and settles satisfactorily the ancient controversy about "The Inheritance of Acquired Characters". 28s.

Theories of the Universe

Edited by M. K. MUNITZ

A comprehensive selection of the most influential contributions to cosmology. It represents the breadth of the whole historical development of man's wonderings and discoveries about the nature of the universe. 48s.

GEORGE ALLEN & UNWIN LTD

40 MUSEUM STREET, LONDON, W.C.1

The Physics of Clouds

By B. J. Mason. Oxford Monographs on Meteorology (*Oxford University Press, 1957, xx+471 pp., illus., £3 10s.*)

Clouds in the atmosphere form an enormous reservoir of water for the maintenance of life on the earth. They also present meteorology with some of its most formidable problems. It is not difficult to see why such great weights of water can remain aloft for long periods (the reason is, of course, that very small drops of water or ice particles descend at a negligible rate) but the manner in which the drops or particles on a cloud grow large enough to fall as rain or snow is by no means obvious. In other words, the question "What causes rain?" is still one of the most difficult (and fundamental) in meteorology.

In this massive tome Dr B. J. Mason, who has done some notable pioneer work in the subject, sets out to give a critical account of the processes of condensation and precipitation and of the various theories which have been advanced to explain them. In the early days of meteorology, clouds were described chiefly in terms of their appearance, and all national weather services still use the Latin terminology invented by Luke Howard over a century ago. Today there is a growing tendency among scientific workers to describe clouds in terms of the physical processes which produce them, such as local penetrative convection, or orographic disturbances. Thus, in studying clouds, both macro- and microphysical processes must be considered.

This book is concerned, in the main, with microphysical processes, but it opens with an excellent essay by Mr F. H. Ludlam on the macro aspects. This section, like the rest of the book, contains some very good photographs.

The initial stage in cloud formation is that of the condensation of water vapour into drops. In pure air (no aerosols or ions) condensation occurs only if supersaturation of the water vapour reaches several hundred per cent. The atmosphere abounds in natural centres of condensation (nuclei), which allow condensation to occur at fractions of 1% supersaturation, but the exact nature and mode of action of condensation nuclei are not yet completely clear. Dr Mason distinguishes between "Aitken" nuclei, "large" nuclei, and what are called "giant" nuclei, with radii greater than 1μ. The Aitken nuclei probably arise mainly as a result of combustion and gaseous reactions, and the larger nuclei are produced mainly by disruption and coagulation. The somewhat unexpected conclusion is reached that, contrary to the view expressed in the older textbooks of meteorology, sea-salt nuclei are a relatively minor constituent of atmospheric aerosol, the rest being "mixed nuclei and the products of natural or man-made fires".

For the working meteorologist, and physicists in general, the most interesting chapters of this book are probably those dealing with the physics of natural precipitation processes and with the artificial stimulation of precipitation ("rainmaking"). In droplet clouds, condensation alone cannot produce drops large enough to fall as rain, and it was not until 1935, when Bergeron produced his classical paper, that an adequate mechanism was suggested. After examination of various means of causing coagulation of small drops, Bergeron concluded that the only physical process which could account for the initiation and maintenance of precipitation required, initially, the presence of a few ice particles in a cloud of supercooled drops at an air temperature below −10°C. In these circumstances the ice particles grow at the expense of the water drops because of the difference between the saturation vapour pressure with respect to ice and with respect to water; further, fresh ice particles are produced because of splintering of the original enlarged crystal, so that a chain process is set up. The enlarged ice crystals fall into the warmer layers, melt, and reach the ground as rain. At one time it was thought by meteorologists that all rain is formed in this way, but it is now clear that coalescence must also be effective, especially in shower (cumulus) clouds.

The emergence of the Bergeron theory has given rise, since the end of the war, to a spate of rainmaking experiments. It was found fairly early that the sprinkling of the tops of supercooled clouds with solid carbon dioxide often produced sufficient ice crystals to bring about notable changes in the cloud, and sometimes snow or rain was seen, some of which reached the ground. But the use of aircraft is expensive and limited in scope, and the advent of commercial rainmaking came after Vonnegut's discovery that minute crystals of silver iodide, in the form of smoke, act as ice-forming nuclei at temperatures below −5°C. This suggested a cheap and easy way of seeding clouds, by producing such smokes from ground generators placed upwind of the area over which precipitation is desired. This is the method invariably used by "weather modification" firms, but as yet there is no agreement among meteorologists that rain can be produced in economic amounts in this way. It now seems to be established that the early claims of several hundred per cent increases in rainfall were unfounded, and that the most that can be hoped for are marginal increases of the order of 10% or 20%. Even these modest claims are hotly disputed, and there are many who say that, as yet, there is no evidence that man has ever succeeded in squeezing a drop of rain out of the sky by such methods. Dr Mason has given a sober and objective account of these highly controversial subjects, and there is little that even the most committed rainmaker could find fault with.

The remainder of the book deals with snow, radar techniques, and the electrification of clouds, with appendices on the dynamics of falling drops. In all of these, established theories are few, and one cannot but admire Dr Mason's courage in attempting to write a comprehensive treatise on a branch of science that clearly is still very much in the process of evolution. In these circumstances one would hardly expect the book to be completely objective and the author, as an active worker in this field, does not attempt to conceal his predilections. But on the whole, the balance is fairly held, and the reviewer found little to criticise in this respect. As a tool for the research worker, this book will be welcomed; as an overall account for the average meteorologist, the treatment is probably too detailed, and it is definitely not a book for arm-chair reading by the amateur.

The illustrations, layout, and printing are of the very high quality expected from the O.U.P.

O. G. SUTTON

Advances in Radiobiology

Proceedings of the Fifth International Conference on Radiobiology, held in Stockholm, August 15–19, 1956. Edited by George Carl de Hevesy, Arne Gunnar Forssberg, and John D. Abbatt. (*Edinburgh, Oliver & Boyd, 1957, xvi+503 pp., 77s. 6d.*)

Although the word radiobiology has obviously come to stay and is in many ways useful, it would be mistaken to suppose that it represented a single scientific discipline in the sense of, say, physiology, or genetics, or ecology. Radiobiology takes all organisms for its experimental or observational material (plants and animals, viruses and man). It must also deal with every step in the reaction of the organism, whatever its level of complexity, to radiation exposure. This must begin with the absorption of energy by living matter, and pass on through primary radiochemical changes, through effects on all the multitudinous biochemical processes that go on within the cell, through the cytoplasmic and nuclear effects studied by geneticists and cell physiologists, through all the complex actions and interactions on and between cells and tissues and

An Introduction to Transistor Circuits

E. H. COOKE-YARBOROUGH, M.A., M.I.E.E.

This book discusses the advantageous properties of transistors which are replacing thermionic valves in electrical devices. Beginning with a concise account of those properties of semi-conductors which influence the electrical properties of transistors, it continues with a description of the properties of transistors as linear amplifiers, including a simplified presentation of formulae. The non-linear circuit aspect is also emphasised with final chapters on the functioning of transistors in electronic devices.

160 pages Line drawings 15s. net

Oliver & Boyd

BJPS

The British Journal for the Philosophy of Science

CONTENTS FOR MAY 1958

ARTICLES

The Two Theses of Methodological Individualism — LEON J. GOLDSTEIN
Theories, Dictionaries and Observation — MARY B. HESSE
Theory-construction and Theory-testing — PETER ALEXANDER

NOTES AND COMMENTS

On Multi-dimensional Time — M. BUNGE

DISCUSSION

On the Space and Time of Images — J. R. SMYTHIES

ARTICLE REVIEWS

Probability and Induction — E. H. HUTTEN
A Television Theory of Perception — J. TUCKER
A Hegelian View of Complementarity — J. AGASSI

REVIEWS

Annual Subscription 42s ($6.25) post free
single copies 10s 6d postage 5d

NELSON

PARKSIDE WORKS EDINBURGH 9

PROGRAMMING for an AUTOMATIC DIGITAL CALCULATOR

By K. H. V. BOOTH, B.Sc., Ph.D.

Birkbeck College, University of London

The availability, in rapidly increasing numbers, of electronic computing machines has meant the emergence of the new technique of preparing calculations for these machines, usually known as programming.

This book contains some of the programmes which have been used on the "All-purpose electronic x-ray calculator" APEXC at Birkbeck College, London. It is the companion volume to "MECHANICAL RESOLUTION OF LINGUISTIC PROBLEMS".

Price 42s.

MECHANICAL RESOLUTION of LINGUISTIC PROBLEMS

By A. D. BOOTH, D.Sc., L. BRANDWOOD, B.A., and J. P. CLEAVE, Ph.D., B.Sc.

Birkbeck College, University of London

The present book contains an account of some of the results which have been obtained by Dr. Booth and his colleagues at Birkbeck College Computational Laboratory on the application of digital calculators to linguistic problems. It is a record of the actual details of the translating techniques achieved with the APEXC computer.

Price 50s.

NATURALLY OCCURRING QUINONES

By R. H. THOMSON, D.Sc., Ph.D., F.R.I.C.

University of Aberdeen

The first comprehensive account of the quinone pigments which form the largest group of natural colouring matters.

The quinones are considered mainly from a chemical standpoint with emphasis on their actions and constitution, and, with biologists in mind, the data on natural sources have been carefully compiled. The literature is completely covered up to the end of 1956, and there are many references to papers published in 1957.

Price 50s.

THREE DIMENSIONAL DYNAMICS

By C. E. EASTHOPE, M.Sc., Ph.D.

University College of Wales, Aberystwyth

The work consists of a vector treatment of the three dimensional motion of a particle and a rigid body. It is intended for second- and third-year students who are reading for an Honours degree.

The material covered includes Vector Algebra, Motion of a Particle, Kinematical Motion of a Rigid Body, Equations of Motion of a Rigid Body, Euler's Equations, Precessional Motion, and Impulsive Motion.

Price 42s.

AIR POLLUTION

Edited by M. W. THRING, M.A.

University of Sheffield

There remains a great gap in our present knowledge of methods for securing cleaner air over our cities and this book, comprising a series of chapters by experts in the field, makes a considerable contribution towards bridging this gap. Most of the chapters are based on lectures given in a course on Air Pollution at Sheffield University in 1956.

Price 42s.

BUTTERWORTHS SCIENTIFIC PUBLICATIONS

88 Kingsway, London, W.C.2

organs, finally to the "whole body" effects observed in experimental mammals and man. This complexity and universality is fairly reflected by the contents of the book under review and by an authorship ranging from physicists to physiologists and from biochemists to haematologists. At Stockholm their papers had been read before an audience drawn from eighteen countries, including the Soviet Union and China. Such heterogeneity of men and material suggests either that the meetings were narrowly sectionalised, or that communication of results and ideas may sometimes have come close to, or even exceeded, the limits of intelligibility for many of the audience. In fact, although the papers are arranged for printing under nine section headings, at the Conference itself only two lecture halls were in use concurrently and the meetings were invariably well attended. Perhaps there were difficulties for all at times, but the vigour of many of the discussions, which are printed in full and form a valuable part of the book, testify to the stimulating effect of the differences of approach and outlook.

Thirty-seven papers have been reproduced, and their diversity of subject-matter has already been indicated. The largest single section (sixteen papers) is that on "Modification of Systemic Irradiation Effects". This is mainly concerned with the administration of chemical substances to animals before irradiation, or of viable cell suspensions afterwards, in attempts to minimise the amount of damage produced. The degree of success achieved is still quite limited, but progress in the understanding of the basic mechanisms involved is reported. Other large sections are those on irradiation effects on the haemopoietic system (eleven papers) and genetic effects (ten papers), the latter including one on back mutation in Drosophila by the Nobel Laureate, Dr H. J. Muller, to whom the volume is dedicated.

The book is extremely well produced, as would be expected from the publishers, but expensive. Its natural place is on the library shelf, where it is likely to be an essential reference work for radiobiologists for several years to come.

C. E. FORD

The Amateur Astronomer

By Patrick Moore (*London, Lutterworth Press, 1957, 317 pp., 25s.*)

This is the sixteenth book (most of them dealing with astronomical subjects) that the author has produced within the last four years. He is Director of the Mercury and Venus Section, British Astronomical Association, and his time is devoted to lecturing and writing on astronomy. The main object of the book is set forth in the foreword—it is for "the beginner who knows nothing whatsoever, but who is nevertheless anxious to make a start with what equipment he can collect at limited costs". A common fault in popular books on astronomy is that too much space is devoted to the solar system and too little to the stellar universe, and the author admits that he has laid himself open to the charge. It is remarkable, however, that, including appendices, 130 pages are occupied with the solar system and 115 pages with the stellar universe, so it does not appear that the author need be apologetic about bestowing too little attention to the latter!

The main principles of telescopes (reflectors and refractors) are explained with diagrams in the early portions of the book, and also the different kinds of mounts: even the grinding of a mirror is explained, and it is certain that some amateur astronomers, after reading this portion, will be inspired to undertake the grinding of small mirrors, assured by the author's encouragement that "making a six- or eight-inch mirror is within the capacity of most people". Eight chapters on different objects in the solar system follow, and these include not only the planets and their satellites, but also aurorae and zodiacal light, comets and meteors, and, of course, the Sun and the Moon come in for their share of attention. Observers of the former may be well advised to take heed to Mr Moore's warning given on pp. 66–7 about the grave danger to injury to the eye unless proper precautions are taken. Beginners studying lunar features will find it advantageous to make a cursory survey of Appendix XII, "The Lunar Maps". These chapters on the solar system provide just the kind of information that beginners require, and the diagrams will prove very helpful. Perhaps special reference might be made to Fig. 28 on p. 75, which shows two boys walking round a chair—illustrating the reason why we never see the other side of the Moon.

Chapter XII, "The Stellar Heavens", departs from such a parochial matter as our solar system—a mere speck in the universe—and with the succeeding chapters, Appendices XV–XXVII, the last appendix including fourteen star maps with explanations, provides all the information necessary for the novice who is desirous of making a serious study of the heavens. The star maps include stars visible in the southern hemisphere and so are suitable for observers in the antipodes.

Amateurs frequently find themselves in difficulties from the fact that they have few collaborators in the vicinity, and for such some astronomical society or association is almost indispensable. Appendix XXVIII supplies a list of such societies and, in addition, some remarks about the British Interplanetary Society, which, it must be admitted, has not always been taken seriously by every astronomer but which recent events are now forcing them to believe that, to say the least, interlunary travel is imminent and, if so, interplanetary travel may not be far off. This is, of course, subject to the maintenance of peace between the Great Powers on our planet.

A few slips and typographical errors have been noticed and a list of these has been sent to the publishers. These could be amended in a second edition, which will almost certainly be called for.

M. DAVIDSON

Brief Notes

Rühren, Betriebstechnik (*Mechanical Stirring Methods and Equipment*) by F. Kneule, has recently been published in the "Dechema-Erfahrungsaustausch" series. It has fifty-seven illustrations, and costs D.M.16 to Dechema members, and D.M.20 for non-members. It can be obtained only on application to the DECHEMA Deutsche Gesellschaft für Chemisches Apparatewesen, Frankfurt (Main) 7.

Under an arrangement with the British Council, the Department of Scientific and Industrial Research have sponsored the publication of *Scientific Research in British Universities 1956–7* (£1 2*s.* 6*d.*, H.M.S.O.). The volume provides brief notes on scientific research in progress in British universities and university colleges during the 1956–7 session. The nature of the projects are described sufficiently to indicate the scope of the research done by university science departments and individual teams of investigators.

The Food and Agricultural Organisation of the United Nations have published *The State of Food and Agriculture 1957* (10*s.*), *Report of the Fourth Regional Conference for Latin America* (5*s.*), *Report of the Third Regional Conference for Asia and the Far East* (5*s.*), and *Tree Plantation Practices in Tropical Africa* (15*s.*). All reports may be obtained at H.M. Stationery Office.

The Nuffield Foundation Report for the Year Ended 1957 (Oxford University Press) is now available. This is the Foundation's twelfth report on the research undertakings to which they have given support and the practical schemes to which they have made grants.

The Federation of British Industries have published their *Report of the Second National Conference Between Industry and the Technical Colleges* (London, May 15, 1957, 5*s.*). The booklet contains the proceedings of the Conference.

We Supply U.S.A. Catalogues

OF PRODUCTS SIMILAR TO YOURS ... FROM U.S.A. COUNTERPART FIRMS

YOU tell us what products and catalogues you are interested in—we obtain and send them to you. You receive from 50 to 200 catalogues per year—also price lists, sample products, sales bulletins, etc. Free descriptive bulletin sent on request.

ESTABLISHED 30 YEARS

CONTINUOUS CATALOGUES SERVICE

Dept. EN-92A, 684 Broadway, New York 12, N.Y., U.S.A.

We have a few choice territories open for representation

TECHNICAL BOOKS

WE CAN OFFER

STOCK. A selection of some 18,000 current and standard books, British and American, on all branches of science and technology well classified for quick reference.

SHOWROOMS. Modern, spacious and well-equipped, on three floors close to Marble Arch. Technical books on first floor.

POSTAL SERVICE. Our Mail Order Dept. prides itself upon speed of despatch and regularly supplies some of the largest industrial undertakings in Britain and overseas. You can order by post with confidence if unable to call.

JOURNALS. Annual subscriptions taken for any British or foreign journal in any language. Customers are advised before subscriptions expire.

STAFF. Experienced, well trained and eager to assist you. They have an excellent knowledge of the books in their care.

Call, write or phone

"BOOKS & CAREERS"

485 Oxford Street, London, W.1

GRO 5664 (5 lines) **1 min. Marble Arch**

UNIVERSITY CORRESPONDENCE COLLEGE

Preparation for the London University

B.Sc. Degree

U.C.C. prepares for General Certificate of Education (for University Entrance and Direct Entry to Degree), and the Final examination for the B.Sc. Degree (General or Special), *obtainable without residence.* Courses are also provided for B.Sc.(Econ.), B.A., and various other London University External Degrees. The College is an Educational Trust with a staff of highly qualified Tutors, and in the last 70 years has enabled many thousands of students to graduate or to pass the necessary exams. for Professional or other careers.

★ **PROSPECTUS free on request to the Registrar,**

48 BURLINGTON HOUSE, CAMBRIDGE

What to Do on the Norfolk Broads

All the information required for a Broadland holiday, comprising: charts, tide-tables, moorings, shopping and sightseeing guides, distance tables, angling, sailing and cruising notes, etc.

Price 2s. 6d. (*postage 9d.*)

JARROLD & SONS LTD, NORWICH

Collecting, Preserving and Studying Insects [25s.]

HAROLD OLDROYD

Instructs in the various aspects of collecting and exhibiting specimens and explains how to make new discoveries known. Suitable for the beginner and detailed enough to serve as a permanent work of reference. *Illustrated.*

The Life and Death of Cells [35s.]

JOSEPH G. HOFFMAN

A leading biophysicist and cancer research specialist examines the mystery of the basic unit of all life—the cell. The chemistry and physics of cells are described and the present objects of research outlined.

Stuttering [25s.]

DOMINICK A. BARBARA

Dr. Barbara maintains that speech is a fundamental element of the whole personality. His original contributions to the subject are based on his findings about himself as a stutterer and on his very wide therapeutic experience.

Science and the Detection of Crime [25s.]

C. R. M. CUTHBERT

The story of the Metropolitan Police Laboratory, New Scotland Yard, told by a former Superintendent who was largely responsible for its formation. The part played by science in the solution of more than 30 criminal cases is disclosed. *Illustrated.*

Hutchinson SCIENTIFIC, TECHNICAL AND MEDICAL PUBLICATIONS

Exciting Month of Science TV

Both the BBC and ITV have started off 1958 with a great boom of delightful science programmes. On December 30, we had the first, and on January 20 the last of four ITV broadcasts, "Conquest of Space". These programmes were produced by Geoffrey Hughes, directed by Peter Morley, and had the gentle guidance of a scientific adviser.

The opening programme, "The Starting Point", was devoted to illustrating first how high man has already reached with a variety of devices and second what problems have to be overcome to reach higher. Essentially an historic survey, the plan adopted was a series of interviews primarily between a questioner, Mr P. Hunt, and a commentator, Mr A. Garratt. Both illustration and film were cunningly interwoven. Some two-thirds of the way through C. Gibbs-Smith was brought in for an interview; he gave an entertaining discourse on the History of Flight and on early rocketry, elaborating especially on the theme of rocket fuels. At this point Mr Garratt returned to the screen and there developed an interesting lively discussion with a rocket expert, Mr Neat. This approach was a novel broadcast experiment in that the discussion was deliberately highly specialised and the viewer had the experience of eavesdropping on a private scientific argument which was not at all being conducted for his benefit. The bewilderment lasted only a short time and was rather a nice departure in production.

The second programme in the sequence, "Man on the Move", used a similar approach, with Mr Hunt interrogating in succession, Mr Garratt, Mr D. N. H. Langton, Dr J. Ring, and Mr Richardson. The first half of the programme, dealing with such space hazards as meteors and cosmic radiation was mere routine, but the second half was highly interesting. In this section Mr Garratt plunged vigorously and enthusiastically into the controversial subject of the "space station". He produced some interesting models, particularly emphasising the zero-gravity problem. He even presented a man drinking upside down as an analogue of minus *g*, and actually produced a model space station of his own design. He was in complete command of his subject.

This performance by Mr Garratt can fairly be described as brilliant and exciting, yet level-headed. He emphasised the radio value of a space station and dismissed as nonsense the possibility that such a station could be used as an aggressive missile base. He touched on the value of a space station for inaugurating *manned* rocketry to the moon and, indeed, made the whole fantasy sound very sober indeed.

The third programme, "The Human Problem", was devoted to a consideration of the stresses and strains a human can expect to experience in the process of space travel. The important current work at the Institute of Aviation Medicine occupied much of the time. Considerable attention was devoted to radiation dangers.

The fourth and final programme, "Man on the Moon", was an interesting experiment as it was essentially a highly speculative discussion between experts on such subjects as the potential magnetic and seismic information we might acquire from the moon, and theories on the condition of the moon's surface. Finally an intriguing technique was adopted in which Mr Garratt, Sir E. Bullard, and Prof. H. Bondi constituted themselves into a kind of Cosmological Brains Trust. Much to everyone's regret they were cut short by the clock just at the most exciting part of their discussion.

We hope to see more of this exciting scientific Brains Trust technique in the future. This broadcast certainly establishes its wide possibilities. From beginning to end these four broadcasts were extremely informative and were put over with attractive dramatisation.

On BBC, "Eye on Research" continued energetically. The sixth programme of the series was broadcast on January 7 and was entitled "The Solid State". This was a slight misnomer, for in fact we were largely treated to a survey of the effects of *radiation damage* on the solid state, but this is a mere detail. Following the previous BBC methods, it was again an outside broadcast, consisting of a visit to Harwell, with Robert Reid as interrogator assisted by Berkeley Smith.

We had once more an unfortunate crop of unexplained technical terms, such as "heavy water", "this keeps uranium fissioning", "this is monitored", and so on. Nothing will make me believe that the main audience, the man-in-the-street, really knows what is under discussion, even if he has seen some of the words in his newspapers. *If the function of the programme is to educate, then it must first elucidate.* Apart from this weakness, which is unfortunately becoming monotonous in this series, the programme was first-rate in every respect. The formidably difficult problem of explaining the crystal structure of metals and alloys to the layman was solved to reasonable satisfaction.

A high-light of the programme was the demonstration of remote control mechanical-handling of radioactive "hot" samples. The shots here were fascinating and the camera technique a veritable *tour de force*. In particular the demonstration of the remote control metallurgical polishing of a specimen, its manipulation on the microscope, and its final telemetering through the microscope to appear at 3000 magnification on a closed circuit television screen, was an outstandingly brilliant demonstration, rarely equalled on television. This programme ended with another of Robert Reid's insistences on the economics and profitable uses of the researches illustrated.

"Point of View", the seventh programme in the series, broadcast on January 14, was a most successful visit to the Applied Psychology Research Unit of the Medical Research Council, Cambridge, with Mr R. Reid interrogating Dr Mackworth and Mr Shackel. These investigators demonstrated clever and convincing electronic devices for revealing movements of the eye during a wide variety of operations, from a mere blinking to a pilot guiding his aircraft down a runway. After rather a lame start the programme warmed up into a lively performance, enhanced by the complete unconcern and naturalness of those taking part in exciting novel experiments where eye movements were translated to a moving spot on a cathode-ray tube display.

The programme was admirable in that it subtly emphasised both the very real character of basic research and at the same time revealed the importance of the individual investigator, an aspect that tends to be lost in such visits to one of the huge national research establishments. That the material being studied was normal man, added enormously to the interest aroused. The broadcast must have opened the eyes of many to the fascination of biophysics.

The only weakness in production was the interpolation of a film sequence where we were treated to the familiar dose of technical terminology without explanation. This weakness seems definitely by now to have been overcome in the "live" broadcast, for Robert Reid was meticulously careful in this broadcast to interject for an explanation whenever the inevitable technical term cropped up. We

A scene from the second programme of the Associated-Rediffusion production, "The Conquest of Space". Mr A. Garratt is seen demonstrating the Goodyear "Meteor" manned space satellite in the background, while in the foreground the floor manager (with earphones) checks the script; the programmes were directed by Peter Morley and produced by Geoffrey Hughes.

were delighted to see this, having urged its adoption for so long.

The eighth programme in this series, "The Dividing Line", broadcast on January 21, was a veritable personal triumph for Dr L. Sayce, the Superintendent of the Light Division. It was a successful broadcast from the first to the last moment and consisted of a visit to the National Physical Laboratory. Dr Sayce, interrogated most ably by Robert Reid, started with the obscure and difficult subject of line gratings, explaining first what they did and then how they were made. With simple experiments and elegant devices he adroitly led the viewer to appreciate the importance of a row of equally spaced close scratched lines. After dealing with their use in infra-red spectrometers we were shown experimentally their application to the new Moiré fringe techniques. At this point a fine film was interpolated showing how grating controlled automation processes have already arrived in the aircraft industry. It was very exciting to see an almost human machine perform complex milling operations, and then to realise that the control went back to a few equally spaced scratched lines on a piece of metal. Nothing could be more calculated to show the real fascination of the implication of pure research in optics. Indeed quite rightly, Robert Reid forcibly drew attention to the elegance of such pure research experiments and the way in which pursuit of these can have profound and unsuspected repercussions on technological processes. It was altogether a fine broadcast.

January 8 saw another of the BBC regular monthly series "Sky at Night", the 15 minutes' talk given regularly by Patrick Moore. Taking Sirius as his subject, Mr Moore elected to discuss astronomical distances and starting off with the statement that Sirius was 8½ light-years distant, succeeded very well indeed in explaining what this meant. His pace was slow, deliberate, and well suited to the subject in hand. Experienced teachers know well that novel concepts, however simple they may seem, often require a wealth of illustration to be thoroughly appreciated, and Mr Moore certainly provides a generous supply of illustration. In fact Mr Moore and Mr. Garratt have emerged recently as notable interpreters of Physical Sciences to adult audiences. Both of these experienced broadcasters have now developed their own characteristic styles, each admirable in its own particular way.

S. TOLANSKY

Nobecutane—a Plastic Surgical Dressing

16 mm.; Colour; Sound; 23 minutes running time. Sponsored by Evans Medical Supplies Ltd. Technical direction by Prof. C. G. Rob, Surgical Unit, St Mary's Hospital, London. Produced by Peter N. Cardew, St Mary's Hospital Medical School, London. For surgical and general audiences, this film is a straightforward account of the properties and use of an ethical preparation which takes the form of a plastic material for application to clean, dry wounds. The purpose of the film is to interest and instruct likely users of this preparation; in this it succeeds admirably, unfolding a very limited subject in an interesting manner.

PETER HANSELL

FAR AND NEAR

Zeta for Brussels

A model of of ZETA, 7 ft. high, which will give a representation of the Harwell experiments towards controlling fusion, is to be a highlight of the British Government Pavilion at the Brussels Universal and International Exhibition this month.

The Brussels model will be in the Technology and Science section of the British Government Pavilion, and will be built to a one-third scale of the original. Its torus (the ring-shaped cylinder) will be made of Perspex so that the interior flash can be seen at 10-second intervals It will be mounted on a platform and so sited that it forms a natural climax to a series of scientific exhibits. Flanking it will be a display about the thirty-five British Nobel prize-winners in the field of science.

An adjacent supplementary display will show an illuminated image of the sun to attract the visitor's eye. The revelation of the results achieved with ZETA have aroused intense world-wide interest, because it is realised that it opens up great possibilities for the people of all nations. The Brussels model will be the first ever shown to the public.

Soviet Scientist's Views on Zeta

Academician I. V. Kurchatov, director of the Atomic Energy Institute of the U.S.S.R. Academy of Sciences, whose work on controlled thermonuclear reactions is well known, has been asked by a *Pravda* correspondent to comment on British achievements in this field and to indicate what progress Soviet scientists are making.

Questioned about the Zeta installation at Harwell, Academician Kurchatov gave a brief description of Zeta and of the principles involved.

> "The British physicists have obtained outstanding scientific results from this installation," he remarked.

He went on to say that Zeta was intended only for scientific experiments and consequently as yet had no significance as regards practical application. The thermonuclear energy released was one-millionth of the energy expended to keep the installation in operation.

"In order to design a thermonuclear reactor for industrial use, several more years of strenuous research are required from scientists throughout the world," he said.

Asked how Soviet physicists are progressing in the field of controlled thermonuclear reactions, Kurchatov said:

"Soviet physicists are working in several directions. At Harwell in 1956 I described one line followed by the Atomic Energy Institute of the U.S.S.R. Academy of Sciences. This work was made known in greater detail in the spring of 1956, at a session of the physics and mathematics department of the U.S.S.R. Academy of Sciences, by Academicians L. A. Artsimovich and M. A. Leontovich, and by scientific workers A. M. Andryanov, S. Y. Lukyanov, S. M. Osovets, and V. I. Sinitsin.

"In August 1956 papers from the same team were read by L. A. Artsimovich and I. N. Golovin at the Stockholm symposium on cosmic electrodynamics.

"This coming September there is to be a second International Conference at Geneva on the Peaceful Uses of Atomic Energy. The first played a big part in pooling the efforts of scientists of various countries but it did not discuss the problem of controlled thermonuclear reactions. The second conference will be devoting much time to this new problem.

"Soviet physicists will describe what they are doing, and in particular work very similar to that being done in Britain —work which, in our country, is being developed on the basis of the ideas suggested in 1950 by Academicians A. D. Sakharov and I. E. Tamm."

Giant Radio Telescope Plan

The world's second-largest radio telescope will be built near Sydney for the Australian Scientific and Industrial Research Organisation.

Dr J. P. Wild, of the Radio Physics Division of the Organisation, announced that the radio telescope would cost £A500,000. It would be only 25 ft. less in diameter than the world's largest radio telescope, built at Jodrell Bank, England. It would greatly assist Australian radio-astronomers, who had been in the forefront of pioneering work in that field.

A British engineer, Dr Barnes Wallis, who planned the breaching of the Ruhr dams for the RAF during the last war, is checking the design.

Research on Mass Communications

Fifty experts on information media, from fifteen countries, meeting recently at UNESCO House, Paris, established the International Association for Mass Communication Research. Created with the co-operation of UNESCO, the new association, which is independent, has its headquarters in Paris, in the offices of the Institut de Presse of the University of Paris. Its function is the promotion throughout the world of the development of research on problems relating to press, radio, television, and films.

At its two-day meeting the constituent assembly approved the association's statutes and work programme. The meeting decided that two subjects inviting special study were: the influence of mass media on children, and the safeguarding of professional secrecy in journalism. This second question will be studied in co-operation with the International Press Institute and the International Federation of Journalists. M. Fernand Terrou, director of the Institut de Presse, was elected chairman of the Association's bureau.

Electronic Aid for Telephone Automation

New electronic equipment, which when working at full capacity will be capable of routing over a hundred telephone calls to different destinations simultaneously, and is expected to make an important contribution to the Post Office's plans for the widespread introduction of automation, began operating at the Lee Green (London, S.E.13) Automatic Exchange last year.

The equipment, which was officially inaugurated by Sir Lionel H. Harris, K.B.E., T.D. (Engineer-in-Chief of the Post Office), is the first of its kind to go into operation in this country. It employs a "magnetic drum" storage device similar to those used in the latest types of computers.

The drum (a bronze cylinder 3 inches deep and 12 inches in diameter) has a capacity for "remembering" numbers and translating them into routeing instructions far greater than the combined efforts of several of the most skilled manual switchboard operators. It can make connexions more efficiently than its human counterpart, and in order that the rare mistake should not go undetected, it has its own built-in supervisory circuits which flash alarms whenever something is amiss.

Known officially as the Magnetic Drum Director, this electronic telephone controlling equipment has been developed by Automatic Telephone & Electric Company Ltd, of London and Liverpool, and is a noteworthy technical improvement on the existing electro-mechanical equipment in use in London and other large cities throughout the world. Its functions are, however, basically the same: it must "store" the dialled numbers, translate them into routeing directions, and ensure that calls are put through in the shortest possible time.

Some seven hundred different instructions can be stored on the magnetic drum, and from these it is capable of translating

any demand for a call into routeing data in only one-tenth of a second. This high operating speed gives it many outstanding advantages over any equipment previously available.

The new equipment will for some time be undergoing extensive "field trials", during which its performance will be closely studied handling public telephone traffic under normal operating conditions.

Robot Weather Station in Antarctic

An automatic weather station, which was built in France to Australian specifications, was scheduled to be set up at Davis Bay in the Antarctic early in the New Year. The robot, the first continuous weather station in the Antarctic, is part of Australia's contribution to the International Geophysical Year. Equipment for the station was scheduled to leave Australia on New Year's Day aboard the Danish ice-breaker, *Thala Dan*.

Details of temperature, atmospheric pressure, and wind speed and direction, will be transmitted in Morse code every six hours for a year by the unattended robot. Broadcasts will be controlled by an electro-mechanical brain which will switch on power supplied by a wind-driven generator, and prepare a radio transmitter, meteorological instruments, and a coding device.

The Australian Minister for the Interior, Mr Fairhall, says similar weather stations may be installed later in remote parts of Australia from which at present no weather reports are available.

Altai-Gobi Earthquake

One of the biggest earthquakes ever experienced took place in the Altai Mountains on the fringe of the Gobi Desert on December 4, 1957.

Interviewed by *Izvestia*, Prof. N. Florentsov, who has been with an expedition to the scene of the devastation, said that a fissure up to 20 m. (66 ft.) wide stretches for more than 250 km. (about 155 miles) through the northern foothills of the Bakhar range—where the epicentre of the earthquake lies.

Particularly severe effects were experienced in the very highest central mountain mass, Ikhe Bogdo. At the epicentre a gap 15 to 18 km. long appeared. The face of the mountain is criss-crossed by numerous deep fissures running in different directions.

During the earthquake, all along the 250-km. fissure the roads and watercourses shifted 3 m. Although in many places water has disappeared, in others big new streams, and rivers 10–12 km. long have appeared.

According to preliminary calculations, Florentsov said, the centre of the earthquake lies at a depth of only 20 to 30 km. below the Earth's surface. He pointed out that the basic fracture in the northern foothills of the mountain range coincides with the line of a surface fault resulting from an earthquake millions of years ago.

Bamboo Sprouts Into Indonesian Science Teaching

The versatile bamboo tree which has been traditionally used in Indonesia to make anything from water containers to musical instruments now has a new career ahead of it in nearly a dozen Indonesian science-teaching centres. Bamboo is only one of the ready-at-hand materials which are now being used in Indonesia to construct low-cost laboratory apparatus. With the help of some ingenuity and the assorted hammers, nails and other tools now being supplied to schools on a "100-rupiah" list of equipment, bamboo sections can be converted into force-pumps or lift-pumps.

This is all part of a new trend in Indonesian science-teaching recently reported at UNESCO House in Paris by Dr H. H. Grantham. As he put it, the trend consists of science-teaching methods which stress "learning by doing instead of sitting and listening". To carry this out, Indonesian educators have opened a Science Teaching Centre at Bandung with apparatus supplied by the United Kingdom under the Colombo Plan.

Equally important is the mushrooming of the Bandung Centre into ten provincial centres scattered throughout the archipelago. In the near future, these centres offering on-the-job training to science teachers will be opened on the islands of Java, Sumatra, Bali, Ambon, and Sulawesi (Celebes).

Forty courses for teachers have already been conducted at the Bandung Centre. Nearly 900 teacher-trainees and supervisors have gone through those courses. (UNESCO.)

Common Cold Still Keeps Its Secret

After eleven years of patient and unremitting work the secret of the common cold (the exact type of virus involved and how it operates) is still eluding the scientists. But they are not without hope of eventual success.

The Common Cold Research Unit, which is run jointly by the Medical Research Council and the Ministry of Health, is again appealing for volunteers so that its work can go on without interruption during 1958. Volunteers are urgently needed.

Dr Christopher Andrewes, of the Medical Research Council, who is in charge of the Unit, said a short time ago: "There have been recent reports from the U.S. of the isolation and cultivation of a virus from a disease resembling the common cold and of the production of a vaccine against it. The virus has been under study by the Salisbury Unit for the last six months and an attempt made to evaluate its importance as a cause of colds. The virus has not yet been isolated from spontaneous colds in Britain and it is very doubtful whether it will rank as a major cause of common colds. It does, however, raise afresh this problem of whether one virus or many are implicated.

"Meanwhile, we certainly cannot do without the services of human volunteers and we are grateful to the many thousands who have so readily come forward in the past eleven years." Comfortable living quarters are provided for volunteers. Fare to and from Salisbury are paid up to a maximum of £3, and 3*s*. a day pocket money is allowed. Volunteers should be between eighteen and forty-five years of age and in normal health. A postcard to the Medical Superintendent, Harvard Hospital, Salisbury, will bring full details.

New Use of Lignin

Experiments by Canadian Government and private research agencies have shown that lignin—the substance that nature produces to hold wood fibres together—can be used to give longer life to tyres, particularly the large-diameter tyres used in military vehicles.

In exhaustive road tests carried out in Texas, these tyres, having synthetic rubber treads reinforced with lignin, showed 15% more resistance to wear than conventional tyres. In laboratory tests synthetic rubber reinforced with lignin develops less heat than conventional synthetic rubber, and the success of these experiments suggests that an all-synthetic large-diameter tyre may eventually be made through the use of lignin.

The lignin used in these tests is a by-product of alkaline pulp manufacture, and as such, it was noted in a report, "has a production potential in North America of 8,000,000 tons a year".

New President of Royal Microscopical Society

At the Annual General Meeting of the Royal Microscopical Society, held in the Rooms of the Society, Mr John Bunyan, L.D.S., R.C.S., Leverhulme Research Fellow, St Mary's Hospital Medical School, Paddington, was elected President.

Mr Bunyan is the Society's fiftieth President and will be in office for two years.

The Society was founded in 1839 and granted the Royal Charter in 1866.

FAR AND NEAR

Zeta for Brussels

A model of of ZETA, 7 ft. high, which will give a representation of the Harwell experiments towards controlling fusion, is to be a highlight of the British Government Pavilion at the Brussels Universal and International Exhibition this month.

The Brussels model will be in the Technology and Science section of the British Government Pavilion, and will be built to a one-third scale of the original. Its torus (the ring-shaped cylinder) will be made of Perspex so that the interior flash can be seen at 10-second intervals It will be mounted on a platform and so sited that it forms a natural climax to a series of scientific exhibits. Flanking it will be a display about the thirty-five British Nobel prize-winners in the field of science.

An adjacent supplementary display will show an illuminated image of the sun to attract the visitor's eye. The revelation of the results achieved with ZETA have aroused intense world-wide interest, because it is realised that it opens up great possibilities for the people of all nations. The Brussels model will be the first ever shown to the public.

Soviet Scientist's Views on Zeta

Academician I. V. Kurchatov, director of the Atomic Energy Institute of the U.S.S.R. Academy of Sciences, whose work on controlled thermonuclear reactions is well known, has been asked by a *Pravda* correspondent to comment on British achievements in this field and to indicate what progress Soviet scientists are making.

Questioned about the Zeta installation at Harwell, Academician Kurchatov gave a brief description of Zeta and of the principles involved.

> "The British physicists have obtained outstanding scientific results from this installation," he remarked.

He went on to say that Zeta was intended only for scientific experiments and consequently as yet had no significance as regards practical application. The thermonuclear energy released was one-millionth of the energy expended to keep the installation in operation.

"In order to design a thermonuclear reactor for industrial use, several more years of strenuous research are required from scientists throughout the world," he said.

Asked how Soviet physicists are progressing in the field of controlled thermonuclear reactions, Kurchatov said:

"Soviet physicists are working in several directions. At Harwell in 1956 I described one line followed by the Atomic Energy Institute of the U.S.S.R. Academy of Sciences. This work was made known in greater detail in the spring of 1956, at a session of the physics and mathematics department of the U.S.S.R. Academy of Sciences, by Academicians L. A. Artsimovich and M. A. Leontovich, and by scientific workers A. M. Andryanov, S. Y. Lukyanov, S. M. Osovets, and V. I. Sinitsin.

"In August 1956 papers from the same team were read by L. A. Artsimovich and I. N. Golovin at the Stockholm symposium on cosmic electrodynamics.

"This coming September there is to be a second International Conference at Geneva on the Peaceful Uses of Atomic Energy. The first played a big part in pooling the efforts of scientists of various countries but it did not discuss the problem of controlled thermonuclear reactions. The second conference will be devoting much time to this new problem.

"Soviet physicists will describe what they are doing, and in particular work very similar to that being done in Britain —work which, in our country, is being developed on the basis of the ideas suggested in 1950 by Academicians A. D. Sakharov and I. E. Tamm."

Giant Radio Telescope Plan

The world's second-largest radio telescope will be built near Sydney for the Australian Scientific and Industrial Research Organisation.

Dr J. P. Wild, of the Radio Physics Division of the Organisation, announced that the radio telescope would cost £A500,000. It would be only 25 ft. less in diameter than the world's largest radio telescope, built at Jodrell Bank, England. It would greatly assist Australian radio-astronomers, who had been in the forefront of pioneering work in that field.

A British engineer, Dr Barnes Wallis, who planned the breaching of the Ruhr dams for the RAF during the last war, is checking the design.

Research on Mass Communications

Fifty experts on information media, from fifteen countries, meeting recently at UNESCO House, Paris, established the International Association for Mass Communication Research. Created with the co-operation of UNESCO, the new association, which is independent, has its headquarters in Paris, in the offices of the Institut de Presse of the University of Paris. Its function is the promotion throughout the world of the development of research on problems relating to press, radio, television, and films.

At its two-day meeting the constituent assembly approved the association's statutes and work programme. The meeting decided that two subjects inviting special study were: the influence of mass media on children, and the safeguarding of professional secrecy in journalism. This second question will be studied in co-operation with the International Press Institute and the International Federation of Journalists. M. Fernand Terrou, director of the Institut de Presse, was elected chairman of the Association's bureau.

Electronic Aid for Telephone Automation

New electronic equipment, which when working at full capacity will be capable of routing over a hundred telephone calls to different destinations simultaneously, and is expected to make an important contribution to the Post Office's plans for the widespread introduction of automation, began operating at the Lee Green (London, S.E.13) Automatic Exchange last year.

The equipment, which was officially inaugurated by Sir Lionel H. Harris, K.B.E., T.D. (Engineer-in-Chief of the Post Office), is the first of its kind to go into operation in this country. It employs a "magnetic drum" storage device similar to those used in the latest types of computers.

The drum (a bronze cylinder 3 inches deep and 12 inches in diameter) has a capacity for "remembering" numbers and translating them into routeing instructions far greater than the combined efforts of several of the most skilled manual switchboard operators. It can make connexions more efficiently than its human counterpart, and in order that the rare mistake should not go undetected, it has its own built-in supervisory circuits which flash alarms whenever something is amiss.

Known officially as the Magnetic Drum Director, this electronic telephone controlling equipment has been developed by Automatic Telephone & Electric Company Ltd, of London and Liverpool, and is a noteworthy technical improvement on the existing electro-mechanical equipment in use in London and other large cities throughout the world. Its functions are, however, basically the same: it must "store" the dialled numbers, translate them into routeing directions, and ensure that calls are put through in the shortest possible time.

Some seven hundred different instructions can be stored on the magnetic drum, and from these it is capable of translating

any demand for a call into routeing data in only one-tenth of a second. This high operating speed gives it many outstanding advantages over any equipment previously available.

The new equipment will for some time be undergoing extensive "field trials", during which its performance will be closely studied handling public telephone traffic under normal operating conditions.

Robot Weather Station in Antarctic

An automatic weather station, which was built in France to Australian specifications, was scheduled to be set up at Davis Bay in the Antarctic early in the New Year. The robot, the first continuous weather station in the Antarctic, is part of Australia's contribution to the International Geophysical Year. Equipment for the station was scheduled to leave Australia on New Year's Day aboard the Danish ice-breaker, *Thala Dan*.

Details of temperature, atmospheric pressure, and wind speed and direction, will be transmitted in Morse code every six hours for a year by the unattended robot. Broadcasts will be controlled by an electro-mechanical brain which will switch on power supplied by a wind-driven generator, and prepare a radio transmitter, meteorological instruments, and a coding device.

The Australian Minister for the Interior, Mr Fairhall, says similar weather stations may be installed later in remote parts of Australia from which at present no weather reports are available.

Altai-Gobi Earthquake

One of the biggest earthquakes ever experienced took place in the Altai Mountains on the fringe of the Gobi Desert on December 4, 1957.

Interviewed by *Izvestia*, Prof. N. Florentsov, who has been with an expedition to the scene of the devastation, said that a fissure up to 20 m. (66 ft.) wide stretches for more than 250 km. (about 155 miles) through the northern foothills of the Bakhar range—where the epicentre of the earthquake lies.

Particularly severe effects were experienced in the very highest central mountain mass, Ikhe Bogdo. At the epicentre a gap 15 to 18 km. long appeared. The face of the mountain is criss-crossed by numerous deep fissures running in different directions.

During the earthquake, all along the 250-km. fissure the roads and watercourses shifted 3 m. Although in many places water has disappeared, in others big new streams, and rivers 10–12 km. long have appeared.

According to preliminary calculations, Florentsov said, the centre of the earthquake lies at a depth of only 20 to 30 km. below the Earth's surface. He pointed out that the basic fracture in the northern foothills of the mountain range coincides with the line of a surface fault resulting from an earthquake millions of years ago.

Bamboo Sprouts Into Indonesian Science Teaching

The versatile bamboo tree which has been traditionally used in Indonesia to make anything from water containers to musical instruments now has a new career ahead of it in nearly a dozen Indonesian science-teaching centres. Bamboo is only one of the ready-at-hand materials which are now being used in Indonesia to construct low-cost laboratory apparatus. With the help of some ingenuity and the assorted hammers, nails and other tools now being supplied to schools on a "100-rupiah" list of equipment, bamboo sections can be converted into force-pumps or lift-pumps.

This is all part of a new trend in Indonesian science-teaching recently reported at UNESCO House in Paris by Dr H. H. Grantham. As he put it, the trend consists of science-teaching methods which stress "learning by doing instead of sitting and listening". To carry this out, Indonesian educators have opened a Science Teaching Centre at Bandung with apparatus supplied by the United Kingdom under the Colombo Plan.

Equally important is the mushrooming of the Bandung Centre into ten provincial centres scattered throughout the archipelago. In the near future, these centres offering on-the-job training to science teachers will be opened on the islands of Java, Sumatra, Bali, Ambon, and Sulawesi (Celebes).

Forty courses for teachers have already been conducted at the Bandung Centre. Nearly 900 teacher-trainees and supervisors have gone through those courses. (UNESCO.)

Common Cold Still Keeps Its Secret

After eleven years of patient and unremitting work the secret of the common cold (the exact type of virus involved and how it operates) is still eluding the scientists. But they are not without hope of eventual success.

The Common Cold Research Unit, which is run jointly by the Medical Research Council and the Ministry of Health, is again appealing for volunteers so that its work can go on without interruption during 1958. Volunteers are urgently needed.

Dr Christopher Andrewes, of the Medical Research Council, who is in charge of the Unit, said a short time ago: "There have been recent reports from the U.S. of the isolation and cultivation of a virus from a disease resembling the common cold and of the production of a vaccine against it. The virus has been under study by the Salisbury Unit for the last six months and an attempt made to evaluate its importance as a cause of colds. The virus has not yet been isolated from spontaneous colds in Britain and it is very doubtful whether it will rank as a major cause of common colds. It does, however, raise afresh this problem of whether one virus or many are implicated.

"Meanwhile, we certainly cannot do without the services of human volunteers and we are grateful to the many thousands who have so readily come forward in the past eleven years." Comfortable living quarters are provided for volunteers. Fare to and from Salisbury are paid up to a maximum of £3, and 3*s*. a day pocket money is allowed. Volunteers should be between eighteen and forty-five years of age and in normal health. A postcard to the Medical Superintendent, Harvard Hospital, Salisbury, will bring full details.

New Use of Lignin

Experiments by Canadian Government and private research agencies have shown that lignin—the substance that nature produces to hold wood fibres together—can be used to give longer life to tyres, particularly the large-diameter tyres used in military vehicles.

In exhaustive road tests carried out in Texas, these tyres, having synthetic rubber treads reinforced with lignin, showed 15% more resistance to wear than conventional tyres. In laboratory tests synthetic rubber reinforced with lignin develops less heat than conventional synthetic rubber, and the success of these experiments suggests that an all-synthetic large-diameter tyre may eventually be made through the use of lignin.

The lignin used in these tests is a by-product of alkaline pulp manufacture, and as such, it was noted in a report, "has a production potential in North America of 8,000,000 tons a year".

New President of Royal Microscopical Society

At the Annual General Meeting of the Royal Microscopical Society, held in the Rooms of the Society, Mr John Bunyan, L.D.S., R.C.S., Leverhulme Research Fellow, St Mary's Hospital Medical School, Paddington, was elected President.

Mr Bunyan is the Society's fiftieth President and will be in office for two years.

The Society was founded in 1839 and granted the Royal Charter in 1866.

Stone-Age Men Who Don't Feel Cold

A party of international scientists have made tests at a mission station 140 miles west of Alice Springs to study the resistance of the aborigines of Central Australia to cold weather. The scientists, led by Dr H. T. Hammell, of the University of Pennsylvania, asked the aborigines to sleep in a refrigerated truck which was once used to carry frozen meat.

The test began last winter when scientists slept in the open alongside the aborigines in Central Australia. They found the nights freezing, but the aborigines slept peacefully without any covering.

Dr Hammell wanted to see if this resistance to cold is seasonal or permanent, and as it was summer in the centre of Australia, they used a refrigerated van for their experiments. Dr Hammell and the other members of his party when the tests were made, slept alongside the aborigines in the van. They visited Darwin later to see whether aborigines in the tropics have the same resistance to cold.

The Central Australian aborigines' immunity to cold has been proved by a group of Australian, American, and Norwegian scientists at the expense of their own comfort. While the scientists shivered, the aborigines with them slept soundly even in a refrigerated van.

Dr Hammell said at Darwin that the experiments showed that the aborigine was more adaptable to heat and cold than Europeans.

Bullet-Proof Lizards

Lizards apparently immune to bullets are among the curiosities of reptile and amphibian life recently collected in Cuba for the Smithsonian Institution by David Hardy, a graduate student of the University of Maryland. The lizards are large iguanas, three to four feet long, with a curious resemblance to antediluvian monsters. Mr Hardy found them in limestone outcroppings and on sandy islands along the Cuban coast.

When shot, Mr Hardy says, the lizards turn over on their backs and lie still, but when approached the apparently dead reptile suddenly "comes to life again", gets on its feet with marvellous speed, and disappears down a hole.

The supposed immunity to bullets, of course, is not quite true. Any creature can be killed if hit in the right place. Still, Hardy says, he captured one specimen with twenty-two shots in its body, apparently none the worse for the experience. The seeming immunity he believes is due to two things—the toughness of the hide and the quite primitive organisation of the nervous system.

Classified Advertisements

OFFICIAL APPOINTMENTS

WIRELESS OPERATOR MECHANICS required by FALKLAND ISLANDS DEPENDENCIES SURVEY for service at isolated British Bases in Antarctic. Must be able transmit and receive Morse at 20 words a minute and be capable elementary maintenance wireless transmitting and receiving equipment. Salary according age in scale £330 rising to £420 a year with all found, including clothing and canteen stores. Keen young men between 20 and 30 years required, preferably single, of good education and high physical standard, with genuine interest in polar research and travel and willing to spend 30 months under conditions testing character and resource. Successful candidates will sail in October. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2C/42653/DI.

SCIENTIFIC OFFICERS required by MINISTRY OF SUPPLY at research and development establishments mainly in south of England, for work in physics, electronics, electrical mechanical or aeronautical engineering, applied mathematics, metallurgy, or chemistry. Qualifications: first- or second-class honours degree in appropriate subject, or equivalent. Candidates should indicate fields of work in which interested. Starting salary in range £595 to £1080 p.a. (superannuable) according to research experience. Rates for women somewhat lower but reaching equality in 1961. Forms from M.L. & N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.8/8A.

LABORATORY TECHNOLOGIST (male or female) required by WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH, NIGERIA, for tour of 12–24 months in first instance, either (*a*) with prospect of pensionable employment or (*b*) on temporary terms. Salary scale (including inducement addition): (*a*) £774 rising to £1284 a year, or (*b*) £834 rising to £1386 a year with gratuity at rate £100–£150 a year. Commencing salary according to qualifications and experience. Outfit allowance £60. Free passages for officer and wife. Assistance towards children's passages and grant up to £150 annually towards maintenance in U.K. Liberal leave on full salary. Candidates must be A.I.S.T. or equivalent and have good knowledge of botany and chemistry with a sound grounding in physics and maths. Training in analytical work or experience in experimental field of biological research an advantage. Female candidates must be single. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M3C/44270/DI.

THE UNIVERSITY OF MANCHESTER

APPLICATIONS are invited from graduates for the post of ASSISTANT LECTURER IN PSYCHOLOGY. Candidates should have special interests or training in experimental and statistical psychology. Applications will be considered from candidates who intend to graduate in 1958. Salary on a scale £700 to £850 per annum with membership of the F.S.S.U. and Children's Allowance Scheme. Applications should be sent not later than April 19, 1958, to the Registrar, the University, Manchester 13, from whom forms of application and further particulars may be obtained.

APPOINTMENTS VACANT

BOOTS PURE DRUG CO. LTD.

BIOLOGICAL RESEARCH

OUR programme of biological research is being expanded. Large new Biology Research Laboratories are now nearing completion and will be opened later this year.

With this expansion of research we have vacancies concerned with pharmacological and toxicological investigation of substances of potential value in medicine and other fields. They will also include fundamental work on drug action. We require:

Senior Research Workers

who have a Higher Degree and/or some years' experience in pharmacological research and

Junior Research Workers

recently qualified graduates or those about to qualify in 1958.

In both cases qualifications in physiology, pharmacy with pharmacology, biochemistry or zoology would be appropriate.

Further details and application forms for these vacancies may be obtained from the Personnel Manager, Boots Pure Drug Co. Ltd., Station Street, Nottingham.

LECTURES AND COURSES

FARADAY HOUSE
ELECTRICAL ENGINEERING
COLLEGE

A THREE-YEAR COURSE, commencing each term, in Electrical Engineering to qualify for Associate of Faraday House and Graduate of the Institution of Electrical Engineers, followed by one year's practical training in Industry to qualify for the Diploma of Faraday House. For Prospectus apply to Department "E", Faraday House Electrical Engineering College, 66 Southampton Row, London, W.C.1.

SOCIETIES

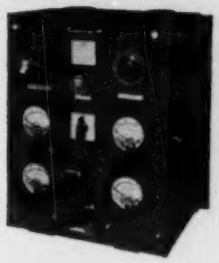
THE BRITISH
INTERPLANETARY SOCIETY
12 Bessborough Gardens,
London, S.W.1

MEMBERSHIP and Fellowship is open to all interested in space-flight, rocket engineering and astronomy.

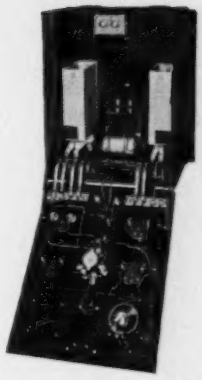
Full particulars of membership, together with a free copy of the Society's Journal and programme of lectures in London and many provincial towns, will be sent on request.

Printed and published in Great Britain by Jarrold & Sons Ltd, Norwich *Editorial Office: High Holborn, W.C.1*

Legg LOW-VOLTAGE POWER UNIT



This low-voltage power unit has been designed to meet the needs of science teaching in secondary schools and provides an efficient source of low voltage A.C./D.C. power for experimental purposes in science laboratories. The front panel is hinged to expose the wiring and component parts for teaching and the interlocking isolation switch renders the unit 'dead' and quite safe to handle.



The unit has been produced to the requirements of the London County Council Education Committee and is already in use in a large number of schools throughout the country

A full technical specification will be sent on request

Legg (INDUSTRIES) LTD · WILLIAMSON ST · WOLVERHAMPTON

335IC

Study at Home

for London University

B.Sc. **Degree**

● Interesting careers with excellent prospects are open to Science graduates both in industry and in teaching. You may prepare for the London B.Sc. at home through the postal courses provided by Wolsey Hall (Est. 1894). Fees are moderate and may be paid by instalments. Tuition can also be arranged in some subjects for M.Sc.(Maths.). **Prospectus** from C. D. Parker, M.A., B.Sc., LL.D., Director of Studies, Dept. WM 81,

WOLSEY HALL, OXFORD

Look at London in Colour

The latest Cotman House publication containing wonderful colour illustrations of the famous places and scenes of historical London

Price **3s. 6d.** (postage **9d.**)

From booksellers or direct:

Jarrold & Sons Ltd, St. James, Norwich, England

VACUUM

PRODUCE IT !

If a high-vacuum rotary pump is unnecessary we manufacture a range of PRECISION WATER JET PUMPS which operate direct from an ordinary water tap producing a vacuum of 12-15 mm. Hg. Available in plastic and metal they are unfailing and quite inexpensive.

MEASURE IT !

The McLeod Gauge is the standard wide-range reference gauge well known for its high standard of accuracy, but often its height is inconvenient. We therefore manufacture a MINIATURE McLEOD-TYPE gauge—the "VACUSTAT" only 9 in. high!

RANGES: 10·0 to 0·01 and 1·0 to 0·001 mm. Hg. Extremely accurate and available in various forms.

VACUUM LEAK-TEST IT !

The finest vacuum equipment is useless if the system is not sound. Therefore, in addition to our range of ultra-sensitive detectors, we produce a simple, inexpensive vacuum indicator and high-frequency leak detector. Ideal for glass systems and for testing the continuity of insulated layers.

EDWARDS HIGH VACUUM LTD

MANOR ROYAL · CRAWLEY · SUSSEX

CRAWLEY 1530 (10 lines) EDCOHIVAC, Crawley

Best of both worlds

When buying furniture, many married couples agree to differ — amicably, one hopes. *He* wants the contemporary look with light-coloured upholstery. *She* wonders how, with children climbing all over it, she would ever be able to keep it clean. In the past, this might have seemed a difficult compromise for it would have meant combining the qualities of soft-cover upholstery with the durability and easy maintenance of coated fabrics.

But I.C.I. has now achieved it — by producing an entirely new type of upholstery covering, 'Vynair'. Like all vinyl-coated fabrics, 'Vynair' cleans instantly at the wipe of a damp cloth, but it also regains shape instantly like any conventional upholstery material, for 'Vynair' is a coated cloth with a difference — it breathes!

'Vynair' is available in sufficient colours and designs to accord with any furnishing scheme. In this particular husband-wife difference, 'Vynair' has the last word by combining the best of both worlds.

Thus, and in a thousand kindred ways, I.C.I.'s research and production are serving the Nation.

ICI